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Quantity, Quality, and Relevance: Central Bank Research, 1990–2003

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The views expressed in this paper are those of the authors.
No responsibility for them should be attributed to the Bank of Canada
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Abstract

The authors document the research output of 34 central banks from 1990 to 2003, and use proxies of research inputs to measure the research productivity of central banks over this period. Results are obtained with and without controlling for quality and for policy relevance. The authors find that, overall, central banks have been hiring more researchers and publishing more research since 1990, with the United States accounting for more than half of all published central bank research output, although the European Central Bank is rapidly establishing itself as an important research centre. When controlling for research quality and relevance, the authors generally find that there is no clear relationship between the size of an institution and its productivity. They also find preliminary evidence of positive correlations between the policy relevance and the scientific quality of central bank research. There is only very weak evidence of a positive correlation between the quantity of external partnerships and the productivity of researchers in central banks.

JEL classification: E59
Bank classification: Central bank research

Résumé

Les auteurs examinent les travaux publiés par 34 banques centrales de 1990 à 2003 et se servent de variables d'approximation pour mesurer la productivité de ces institutions durant la période considérée. Les résultats sont obtenus avec et sans la prise en compte de la qualité des recherches et de leur pertinence au regard des politiques publiques. Les auteurs constatent que, dans l'ensemble, les banques centrales recrutent plus de chercheurs et publient davantage de travaux depuis 1990. Plus de la moitié de toutes les études publiées sont américaines, même si l'on note que la Banque centrale européenne tend à s'imposer rapidement comme un important centre de recherche. Au chapitre de la valeur et de la pertinence des publications, les auteurs n'observent généralement aucune relation claire entre la taille d'une banque centrale et sa productivité. Des données préliminaires font toutefois apparaître une corrélation positive entre la valeur scientifique des travaux et leur pertinence sur le plan des politiques. Par ailleurs, la relation entre le nombre de partenariats externes et la productivité des chercheurs au sein des banques centrales est positive mais peu significative.

Classification JEL : E59
Classification de la Banque : Recherches menées par les banques centrales

1. Introduction

Research is increasingly seen as critical for the success of central banks in fulfilling their mandates. It provides a strong conceptual and empirical basis for policy-making and for better communication of policies to the public. Accordingly, many central banks have invested significant resources in recent years into improving their research capabilities. At the same time, there is growing demand for accountability on the part of public agencies (including central banks) and a commitment of their managers to focus on results and to work towards strengthening performance. It is in this context that there has been increased interest in assessing central bank research output.

Jansen (1991) and Rapoport and Yi (1997) compare the publication records of the various components of the U.S. Federal Reserve System; Eijffinger, de Haan, and Koedijk (2002) and Jondeau and Pagès (2003) focus on those of central banks in Europe. Goodfriend, König, and Repullo (2004) provide a detailed assessment of the economic research activities of the European Central Bank (ECB). Dusansky and Vernon (1998) and Scott and Mitias (1996) use data on publications in scientific journals to rank university economics departments in the United States. A project recently sponsored by the European Economic Association to rank European research centres resulted in the publication of four papers (Combes and Linnemer 2003; Coupé 2003; Kalaitzidakis, Mamuneas, and Stengos 2003; Lubrano et al. 2003) in the *Journal of the European Economic Association*.

Although the details vary on the methodological approaches used to produce these papers, many share a common characteristic: they focus on publications in scientific journals as the main indicator of quality-adjusted research. Three reasons are given to justify this approach. First, there is a broad consensus among researchers that the selection criteria used by most scientific journals, particularly the use of expert anonymous referees to evaluate articles, makes publishing in these journals a good indicator of quality. Second, although it can be quite labour-intensive, measuring the number of publications in scientific journals is feasible. Indeed, it is possible to trace a researcher's publications in scientific journals using tools such as *EconLit*, the American Economic Association's electronic bibliography of economics literature throughout

the world.[1] Third, various rankings of scientific journals have been produced. Even if these rankings can be controversial, they make it much easier to assess the quality of scientific journals than that of other literature streams, such as working paper series or books, for which there is no widely accepted measure of quality.

Our first main contribution builds on the existing literature: we provide a systematic comparison of the research output of central banks from Western Europe, North America, Australia, New Zealand, Japan, and Israel based on publications in economic journals. To our knowledge, a systematic comparison encompassing such a large group of central banks has not yet been done. To achieve this, we built a database detailing publications by central bank researchers in all academic journals included in *EconLit*. Our database also includes various proxies for the number of researchers in central banks, including responses to questionnaires that were sent to central banks. We test the robustness of our conclusions by exploring variants of our output and input measures.

Our second main contribution is an assessment of the policy relevance of central bank publications. While we agree that publication in academic journals is a good indicator of the scientific quality of research output, to focus exclusively on journal publications has obvious limitations. In particular, it implies an excessively narrow view of the role of research in policy institutions. Central bank researchers are not exclusively paid to publish papers of interest to the academic community. They are expected to conduct research that assists policy-makers in making more informed decisions. An evaluation of research output must therefore include an assessment of the extent to which the research helps central banks conduct monetary policy, oversee the payments system, and manage foreign exchange reserves.

The management literature tells us that "What gets measured gets done" (Osborne and Gaebler 1992, 146). An exclusive focus on publications in refereed journals may bias central bank research efforts towards academic criteria and away from policy relevance. For that reason, we see a clear need to measure policy relevance, but such measurement is difficult because of the lack of good, agreed-upon data and methodology. A possible approach would be to examine in

[1] See <http://www.econlit.org>.

detail how specific papers published by central banks are fed into policy discussions. Goodfriend, König, and Repullo (2004) follow this approach in their evaluation of research at the ECB. However, it can be highly subjective and cannot be applied to the large number of central banks that we examine.

We propose a new approach based on the premise that having a paper cited in a publication of a policy institution is a good indicator of its usefulness for addressing policy issues. We measure policy relevance by counting the number of citations of central bank working papers in publications of the Bank for International Settlements (BIS) and the U.S. Federal Reserve System (for central banks other than the U.S. Fed). We choose these institutions because they pursue interests in practically all policy issues that are relevant to central banks. Also, the websites of these institutions are conducive to citation searches. Still, this is a very labour-intensive task. An obvious extension would be to include citations by other international policy institutions, such as the International Monetary Fund, the Organisation for Economic Co-operation and Development, or other central banks, but this would represent a considerable amount of additional work. Our efforts should be seen as a first step towards considering policy relevance in the evaluation of central bank research output.

By developing separate measures for scientific quality and policy relevance, we do not mean to imply that there necessarily is a trade-off between the two. In fact, we expect that they tend to reinforce each other. In particular, *ceteris paribus*, papers of good scientific quality are likely to be more useful for policy-makers than papers of lower quality. Also, we expect that policy relevance is an asset for publication in top journals. As another contribution to the literature, we conduct a preliminary examination of whether there is a link between the scientific quality and the policy relevance of central bank papers. Our findings in this area are consistent with our expectations.

Eijffinger, de Haan, and Koedijk (2002) find that the average product of European central banks that have a small number of researchers tends to be superior to those that have a larger number of researchers. Angelini (2003), however, argues that this result no longer holds when corrected data on the number of published papers are used, and Jondeau and Pagès (2003)

conclude that there is no significant relationship between average product and the number of researchers in Eijffinger, de Haan, and Koedijk's (2002) study. We revisit this question with our larger set of data.

Collaboration with external researchers may be an efficient way to achieve greater research productivity. In this paper, we assess the impact of these partnerships on the quantity, scientific quality, and policy relevance of central banks' research.

The rest of this paper is organized as follows. In section 2 we provide our data and explain our methodology. In section 3 we examine research output based on working papers and publications in refereed journals. In section 4 we focus on the policy relevance of central bank research. In section 5 we examine factors that can explain the quantity, quality, and policy relevance of research output. In section 6 we offer some conclusions and suggest avenues for future research.

2. Data and Methodology

In this section, we provide our data on the number of researchers in central banks. We also explain how we measure research output, and how we assemble data on research input and output to produce indicators of central bank researchers' average product.

2.1 Measuring research inputs

Our main measure of the number of researchers in central banks is based on responses to letters we sent the banks inquiring about the number of researchers they employed over the period 1990–2003. In our letters, we defined a researcher as an employee who performs research at least 50 per cent of the time. We defined research as work that has the potential to result in research publications such as working papers or academic journals. Most of the central banks we contacted provided the requested information, although with some difficulty in a few cases, and

some not for the entire 1990–2003 period.[2] We use this definition as our base-case measure of research inputs, since it reflects the self-assessments of each central bank and is based on a precise definition.

These data are shown in Table 1a of Appendix A. We observe that the number of researchers has increased in many central banks, reflecting their greater emphasis on research. Some central banks, particularly the ECB, the Deutsche Bundesbank, the Federal Reserve Bank of Chicago, and the Bank of Canada, show considerable increases over the reported period.

A limitation of this approach is that research time may be allocated differently in the various central banks. For instance, some central banks may have a few employees highly specialized in research activities. Our definition could lead to an underestimation of the number of researchers in those central banks compared with central banks where a large number of employees invest slightly more than 50 per cent of their time performing research.

To assess the robustness of our results, we consider two alternative sources of information on research capabilities. First, we consider the number of PhDs (Table 1b). These data are also compiled through our central bank survey. Second, we count the number of individuals who "revealed" themselves as researchers by authoring working papers and/or journal articles (Table 1c). This approach builds on that of Jondeau and Pagès (2003), who approximate the number of researchers in central banks by the number of authors of articles published in scientific journals. In our view, a limitation of this approach is that many researchers never publish in journals, as Combes and Linnemer (2003) discuss. The proportion of researchers who do not publish in scientific journals may vary across central banks, which could introduce biases into our comparisons. To improve on this approach, we take working papers into account. Our measure is thus based on the number of central bank employees who published at least one working paper *or* one refereed journal article in a given year (avoiding double counting). For this measure of research input, we limit ourselves to the 1999–2003

[2] Instead of using our definition, the Bank of England and the De Nederlandsche Bank found it more convenient to provide the number of researchers on a full-time equivalent basis. The Bank of Sweden provided us with the number of staff in its research department. We made no adjustment for these differences.

period. This limited sample reflects the fact that working papers are not available on the websites of many central banks for longer sample periods. These data are shown in Table 1c.

Comparing our base-case measure of the number of researchers with the alternative measures, we first find that the number of researchers is close to the number of employees with PhDs in most central banks. However, some central banks, for instance the Swiss National Bank, the U.S. Board of Governors of the Federal Reserve System, the Bank of Greece, the Bank of Sweden, and the Bank of England, have a much larger number of employees with PhDs than researchers. For these institutions, we find that the ratio of PhDs to researchers is 1.5-to-1 or more (Table 1d).

Second, we find that a few central banks have many more employees publishing papers than researchers, based on our definition. Some of these central banks, for example the U.S. Board of Governors and the Bank of England, are also part of the group that has more PhDs than researchers. However, this is not always the case. For instance, the Swiss National Bank has a relatively large ratio of PhDs to researchers, but a relatively low ratio of authors of papers to researchers.

A limitation of this second alternative is that central banks may have different publication policies. In particular, some might be more liberal than others, in that they publish a broader variety of papers (including policy or communication papers) or impose less stringent criteria for publications (section 3.1 provides evidence of this). Moreover, these policies can change through time. This approach may lead to a relative underestimation of the research capabilities of central banks that have strict publication policies.

A number of limitations to these alternative measures of research inputs are worth highlighting. The limitations of the number of employees with PhDs as a proxy for research capabilities are: (i) some institutions may ask these employees to perform activities other than research (administration, policy analysis); (ii) researchers in many central banks often do not hold PhDs; and (iii) PhDs may not be equivalent across countries. Still, we think this approach provides information that is a good complement to our measure of the number of researchers.

Also, we will use this information to determine whether having more PhD employees is correlated with more research output per researcher.

Despite some of the limitations identified above, we believe that, taken together, our three measures provide useful information about the research capabilities of central banks. Future work may consider using more precise information. For instance, it would be interesting to know how much money central banks spend on research activities. It would also be interesting to learn more about the types of PhDs employed by central banks. Unfortunately, we expect that this information would be difficult to obtain for long sample periods and for a large number of central banks.

2.2 Measuring research output

We study three aspects of the research output of central banks: its quantity, its scientific quality, and its policy relevance. We use publications in scientific journals by central bank researchers and working papers published by central banks as our main sources of information on research quantity. We capture research quality by assigning weights to the published output, which are simply functions of existing quality rankings of economics journals. To assess policy relevance, we count the number of citations generated in documents published by the BIS and the U.S. Federal Reserve System.

To disseminate their research to external audiences for the purpose of either communicating new research findings or to solicit feedback from external specialists, many central banks maintain active working paper series. Unlike academic institutions, the working papers published by central banks tend to be more "polished," in that many have gone through a formal or informal refereeing process. For this reason, compiling the number of working papers can provide a proxy for a central bank's research output. Of course, publishing in academic journals is usually more demanding in terms of scientific quality. Accordingly, we emphasize publications in these journals as our main indicator of quality-adjusted research output.

To calculate the number of publications in academic journals, we searched the content of an extensive list of 799 journals. We require a vast list because central bankers publish their work in a wide variety of journals. Many of these journals are not included in the most "elite" list of top journals because the central bank researchers in our sample often publish in national journals that may not be included in shorter lists (Combes and Linnemer 2003). Focusing exclusively on a list of top-10 or top-20 journals, most of which are published in the United States, would be too limiting.

There are two commonly used approaches to ascribe publications to research institutions. The stock approach (used, for instance, by Combes and Linnemer 2003) counts the past production of the current employees of central banks. In contrast, the flow approach counts production at the time of publication. The stock approach is useful to assess the past publishing record of current researchers in an organization, but this is not our objective. We seek to assess the research output of central banks over time. We thus follow previous studies in this field by choosing the flow approach (Jondeau and Pagès 2003; Eijffinger, de Haan, and Koedijk 2002).[3]

We have constructed a database detailing publications by central bank researchers in academic journals included in *EconLit*.[4] Some central banks have their own publications included in *EconLit*. We exclude these from our list to avoid the obvious bias that their inclusion would imply.

Formally, we measure the research output of central banks in academic journals as follows. The journals are indexed as $j = 1, \ldots, J$, where the total number of journals, J, equals 799. The central banks are indexed as $k = 1, \ldots, K$, where the number of central banks considered, K, is 34. With our sample period covering the period 1990 to 2003 inclusively, the time index is $t = 1990, \ldots, T$, where $T = 2003$. We can therefore denote the number of papers published in journal j by central bank k in year t as $q_{j,k,t}$. The sum of central bank k's output over the whole period in all academic journals is computed as

[3] Using journal publications as a measure of research output can be imprecise, since publication policies can vary across central banks and across time.
[4] The search keywords used to perform searches in *EconLit* are listed in Appendix C.

$$Q_k = \sum_{t=1980}^{T} \sum_{j=1}^{J} q_{j,k,t} \,. \qquad (1)$$

In equation (1), each journal article is given the same weight, so no consideration is given to the length of the published articles. As a robustness check, we also report results for the case where research output is defined as the sum of the number of published pages in academic journals. Denoting $p_{j,k,t}$ as the number of published pages in journal j by central bank k in year t, the sum of published pages in all journals over the full sample is therefore

$$P_k = \sum_{t=1980}^{T} \sum_{j=1}^{J} p_{j,k,t} \,. \qquad (2)$$

To control for differences in the quality and reputation of journals, we use the ranking proposed by Combes and Linnemer (2003).[5] One advantage of this ranking is that it comprises all journals listed in *EconLit*, the set of journals considered in this study. The quality-adjusted measures of published journal articles and of published pages in academic journals are, respectively,

$$\tilde{Q}_k = \sum_{t=1980}^{T} \sum_{j=1}^{J} \omega_j \times q_{j,k,t} \,, \text{ and} \qquad (3)$$

$$\tilde{P}_k = \sum_{t=1980}^{T} \sum_{j=1}^{J} \omega_j \times p_{j,k,t} \,. \qquad (4)$$

where the adjustment factor in equations (3) and (4), ω_j, assumes the values 1.0, 0.67, 0.50, 0.33, 0.17, or 0.08, depending on the ranking of the journal in which the article is published. These weights are taken directly from Combes and Linnemer (2003). The complete journal list is provided in Appendix B, so $\omega_j = 1.0$ for journals $j = 1, \ldots, 6$, $\omega_j = 0.67$ for journals $j = 7, \ldots,$

[5] Another approach would be to approximate the scientific quality of a given paper by the number of times it is cited in papers published in a set of academic journals. However, this would represent a more ambitious endeavour, since the data on journal citations are difficult to obtain for a broad selection of journals. Also, the rankings that we use to weight the various journals are partly based on citations by other journals, which means that our approach already implicitly takes this consideration into account.

21, etc. For example, journals such as the *American Economic Review*, *Econometrica*, and the *Journal of Political Economy* are assigned a weight of 1.00, the *Journal of Monetary Economics* and the *Journal of Money, Credit, and Banking* are assigned a weight of 0.67, the *Journal of Banking and Finance* and the *Journal of Macroeconomics* are assigned 0.50, and *Economic Inquiry* and *Economica* are assigned 0.33. More than half of all journals are located in the bottom category and are assigned a weight of 0.08. These are usually smaller regional or specialized journals, or relatively new journals that have not yet generated sufficient citations or established a firm reputation in the discipline. To estimate the average quality of papers published by a central bank, we can simply compute the average ω_j of its journal publications.

In robustness checks, we consider alternative sets of journal-quality weights. In particular, many central banks tend to publish in their own national scientific journals: central banks are most interested in research studies related to their national economies. Since many of the highly ranked journals in Combes and Linnemer's list are based in the United States, we consider an alternative weighting scheme in which each country's top-ranked journal is assigned a weight of 1.00.

We also propose a new approach to measure the output of policy-relevant research, based on the premise that having a paper cited in a publication of a policy institution means that an author at such an organization deemed the paper as useful in addressing a given policy issue. We measure policy relevance by counting the number of citations of central bank working papers in publications of the BIS and the U.S. Federal Reserve System.[6] We choose these institutions because they pursue interests in most policy issues that are relevant to central banks. Also, their websites are conducive to citation searches.

The main disadvantage of our approach is that it underestimates the number of citations of central bank work, since it does not capture citations of research papers published in journals. Ideally, we would like to count citations by the BIS and U.S. Fed of both journal articles and working papers in our construction of an indicator of policy relevance. Our decision to exclude publications in academic journals from our citation search reflects the amount of work that

[6] The search keywords used for both the BIS and the U.S. Fed websites are provided in Appendix D.

would be required to link central bank journal publications with citations in BIS and U.S. Fed documents. Fortunately, because of the often substantial lags involved in publishing in scientific journals, the BIS and U.S. Fed often cite working paper versions of a paper instead of the journal-published versions. We leave the inclusion of citations of publications other than central bank working papers for future work.

Our study includes basically all BIS publications, by both BIS staff and external contributors. For instance, research papers presented at BIS conferences by central bank economists and published in conference papers and proceedings are included. The vast majority of the latter are from central banks. Our approach thus takes into account both the opinions of BIS staff and those of staff from other central banks. Self-citations (i.e., citations of a central bank's own work by staff of that central bank) are excluded to avoid the bias this would imply.

To measure output per researcher, we simply divide the output statistics (1) through (4) by our proxies for the number of researchers in a central bank. We let $n_{k,t}$ denote the number of researchers at central bank k in year t, and N_k denote the sum of researchers over the full sample. For example, the average annual number of journal publications per researcher at central bank k over the full sample is computed as

$$\frac{Q_k}{N_k} = \sum_{t=1990}^{T} \left(\frac{\sum_{j=1}^{J} q_{j,k,t}}{n_{k,t}} \right). \qquad (5)$$

We also consider the number of working papers published by central banks as an alternative measure of research output. Although working papers are subject to fewer quality controls than papers published in academic journals, central banks usually have internal quality controls to ensure that their working papers conform to minimum quality standards. Also, the

total output of working papers may be a useful leading indicator of forthcoming publications in journals, contributing to the analysis of recent trends in the research output of central banks.[7]

A factor that may influence research output is the amount of collaboration with external researchers. Central bank researchers may not be as heterogeneous as their academic colleagues, so collaboration with them may be an efficient way to achieve greater research productivity. Accordingly, we assess the impact of these external partnerships on the quantity, scientific quality, and policy relevance of the research produced by central banks. To achieve this, we track the contributions of external collaborators to working papers and journal publications in order to ascertain which institutions use external contributors more intensively.

3. Research Output

As noted in the introduction, research is conducted by central banks largely to assist policy-makers make better-informed decisions. Since the targeted audience for some research papers is internal, and therefore some papers are never distributed outside of the institution, it is impossible to precisely measure the complete body of research produced within central banks. For this reason, we must use publicly available research output proxies to measure the output of central banks. Nevertheless, researchers at central banks and other institutions recognize the importance of distributing research papers outside their walls, to inform the public about the work being conducted, stimulate discussions on policy-relevant issues, and, in the case of working papers, announce new research findings and solicit feedback from outside experts.

In this section, we examine the research output of central banks using the two most common publicly available measures: working papers and journal publications. For the latter, we also consider quality-adjusted measures based on the quality of the journal. In addition, we provide data on the number of journal publications per researcher in central banks.

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[7] In the cases of the Bank of Japan, the Bank of Greece, and the Bank of Israel, we include only working papers published in English. This clearly implies a significant underestimation of the number of working papers published by these central banks, given that many are published in Japanese, Greek, and Hebrew. It is not feasible for us to conduct searches for documents that are published with non-Latin characters.

3.1 Working papers

Table 2 of Appendix A lists the number of working papers published by each central bank between the years 1999 through 2003.[8] We find that the Board of Governors of the Federal Reserve System (henceforth BoG) averages over 90 working papers per year, which leads all other central banks. The ECB is second in this category, despite the fact that it began operation only in January 1999. Its standing reflects the significant rise in its research output in the past three years, which coincides with the hiring of more research economists and the implementation of clear research agendas. Tied for third place are the De Nederlandsche Bank and the Bank of Finland, relatively small institutions, which have both published, on average, 44.6 working papers per year.

Following the three leaders are several institutions that publish, on average, 30 to 40 working papers per year. These include the central banks of Japan and Canada, as well as the Federal Reserve Banks of Chicago, St. Louis, and Atlanta.

As a whole, central banks have been increasing their output of working papers every year. Although the ECB accounts for a large proportion of the increase in total central bank working papers, its exclusion still leads to a notable increase in research output. The total output of working papers increased by 50 per cent between 1999 and 2003 for all central banks, and by 35 per cent when we exclude the ECB. This clearly demonstrates that central banks have been conducting more research, and will likely be reflected in more journal publications for central bankers in the coming years if working papers can be viewed as a leading indicator of such publications. Along with the ECB, central banks that have demonstrated notable upward trends (i.e., an average increase of more than four working papers per year) in the number of working papers published over this period include the central banks of the Netherlands, Canada, Finland, and England, as well as the Federal Reserve Banks of Atlanta, St. Louis, and Philadelphia. The only statistically significant negative trend is detected for the Riksbank, whose working paper output has been falling by about three per year.

[8] The list of working papers was retrieved from the websites of central banks. The working paper series considered for each central bank are identified in Appendix E.

One factor that may influence working paper output is the prevalence of external authors in a central bank's working paper series. In many instances, these external authors are short-term visitors at the central bank, and in others they co-author working papers with central bank researchers. Co-authorship of research papers is quite prevalent in the economics community, since the degree of specialization required to make original contributions to the field often calls for the collaborative efforts of researchers with complementary areas of expertise. Central bank researchers may not be as heterogeneous as their academic colleagues, so collaboration with external researchers may be an efficient way to achieve greater research productivity and gain fresh ideas.

Table 3 of Appendix A reports the percentages of external collaboration in each institution's working paper series. These percentages are computed by assigning weights to the contributions of external authors, with a paper receiving a weight of 0 if it has no external authors, 1 if it was written solely by external authors, or $e/(c+e)$ if co-authored between central bank and external researchers, with c representing the number of "in-house" central bank researchers co-authoring a paper and e representing the number of external authors. For example, if the authorship of a working paper consists of two central bank authors and one external collaborator, then the weight assigned to the external collaborator's contribution would be 0.33, or 33 per cent.

By summing the weights assigned to the contributions of external authors over all papers published in each institution's working paper series between 1999 and 2003, we derive the aggregate percentage of external authorship (column 1 of Table 3). In the cases of the central banks of Austria, Belgium, and Switzerland, we find that the contributions of external researchers to the authorship of all working papers is more than 50 per cent, indicating that researchers at these institutions either collaborate with external researchers a great deal, or that many external economists publish the results of their research in the working paper series of these central banks. To determine whether the former or latter explanation is more pertinent, in the second column of Table 3 we list the percentage of papers that have been published in each institution's working paper series that have been solely authored by external researchers, without the collaboration of central bank economists. We find marked differences between many central

banks: some have very high percentages and some have percentages of zero. For eight central banks (the Bank of Japan and seven European institutions), more than 22 per cent of their working papers have been written by external authors. For the remaining 25 central banks, the number is below 13 per cent. These differences may reflect different uses of the central bank working paper series; the central banks of some countries may be more open to publishing the papers of external authors if the papers pertain to domestic economic issues and if alternative publication outlets are not readily available.

The third column of Table 3 lists the percentage contribution of external authors to working papers that have at least one central bank author. Based on this measure, researchers at the Danmarks Nationalbank have collaborated the most with external researchers: 45 per cent of the papers published by its staff were co-authored with external researchers. However, this percentage is computed using a relatively small sample (11 working papers); among the institutions with more active working paper series, the measure of collaboration is 41 per cent at the Atlanta Fed and 38 per cent at the Cleveland Fed. The prevalence of co-authorship is relatively high in the United States as a whole compared with other central banks, ranging from 20 per cent (at the BoG) to 28 per cent (at the San Francisco Fed) for the remaining U.S. institutions, but comprising only 5 per cent at the Bank of Japan, 7 per cent at the Australia and New Zealand Reserve Banks, 10 per cent at the Bank of Canada, and 12 per cent at the Bank of England.

3.2 Journal articles

Table 4 of Appendix A lists the contribution of external co-authors to central bank publications in academic journals. Over the 1990–2003 sample, we find that Atlanta Fed researchers collaborated with external co-authors relatively more than researchers from other central banks. Indeed, 36 per cent of published papers associated with the Atlanta Fed can be attributed to researchers who are not employed by that institution, but who have collaborated with Atlanta Fed researchers. In the more recent 1999–2003 period, collaboration percentages are greatest for the National Bank of Belgium and the Federal Reserve Banks of Kansas City, Dallas, and Atlanta.

It is difficult to detect any significant trend as to whether collaboration with external authors has been increasing in recent years. In 2003, between 27 and 30 per cent of authors of papers associated with central banks were external, which is somewhat higher than the 23 per cent figure for 1993 and 1994 (data available but not reported in the tables). At this point, however, we have too few observations to deduce whether external collaboration has been increasing recently.

Table 5a of Appendix A lists the total number of journal articles published by central banks from 1990 to 2003 and for the period 1999–2003. We find that the BoG is first in total output, with 920 publications, or an average of 66 per year. The New York Fed is a distant second, with a little fewer than 23 publications per year, followed closely by the Banca d'Italia and the Minneapolis Fed. Several institutions average between 10 and 16 publications per year, including several Federal Reserve Banks (Chicago, Dallas, Atlanta, Cleveland, Philadelphia, and San Francisco) and the central banks of England, Spain, and France. To put the BoG's output into perspective, it alone accounts for 19 per cent of the publications of these 34 central banks since 1990, and as a whole the U.S. Federal Reserve System accounts for 60 per cent of all central bank publications since 1990.

In total, these 34 institutions have published more than 4,800 articles over a period in which 456,802 papers have been indexed in *EconLit*, indicating that central banks are responsible for about 1 per cent of the total new body of knowledge in economics over the past 14 years. Considering that there are thousands of academic institutions and other research centres that contribute research to the field, such output is non-negligible. We further note that there has been a strong upward trend in published central bank research, especially between 1990 and 1998, a period in which the total of all central bank publications nearly doubled, increasing from 201 to 398. Published output remained strong from 1999 to 2003, averaging 433 articles per year, with a high of 477 in 2001. By institution, the most pronounced upward trends are detected for the New York Fed and Banca d'Italia over the whole sample. For the 1999–2003 period,

significant upward trends have been detected for the ECB, Deutsche Bundesbank, and De Nederlandsche Bank.[9]

As stated in section 2, not all publication outlets are perceived as being of similar quality; those that have more rigorous selection processes are deemed to be of superior quality. For this reason, in Appendix B we adjust the raw published output by a quality index that is constructed using the ranking of academic journals discussed in section 2.

Table 5b of Appendix A lists the average article quality index for each institution. We find that, at 0.67, the Minneapolis Fed has the highest quality index, followed by the Richmond Fed at 0.50 and the Boston Fed at 0.49. Most other members of the U.S. Federal Reserve have a quality index above 0.40. Among other international institutions, Israel and Portugal have the highest quality indexes at 0.40. Using this index, quality-weighted production measures can be produced by multiplying the quality index by: (i) the total article count (Table 5b), (ii) the article count adjusted for the contribution of co-authors (Table 5c), and (iii) the total page count adjusted for the contribution of co-authors (Table 5d). These quality adjustments tend to be advantageous to the rankings of the U.S. institutions: the BoG and the Minneapolis, New York, and Chicago Federal Reserve Banks occupy the first four positions, respectively, using any of these three quality-adjusted measures, and for either of the 1990–2003 or 1999–2003 periods. The Bank of England, the Banca d'Italia, and the ECB are the sole non-American representatives among the top 10 central banks in quality-adjusted output.

With few exceptions, the quality-adjusted rankings in Tables 5b through d are fairly similar; most institutions do not rise or fall by more than one or two positions. However, these institutional rankings are a function of the weights assigned to the journals. Since most of the top-ranked journals are U.S.-based, this may induce a bias in favour of the U.S. institutions. Central banks that produce research papers using data on their own country may face more significant hurdles in trying to publish their work in U.S.-based journals. For example, the *Economic Record* may be the most appropriate outlet for research produced by the Reserve Bank

[9] Gaspar and Vega (2002) discuss the hypothesis that the creation of the ECB stimulated research in the Eurosystem.

of Australia, but the lower quality weighting applied to this journal may penalize Australian researchers who publish in their national journal.

To determine whether this possible U.S. bias seriously affects our results, we perform the following robustness checks. First, for each country in our sample, we identify the national journal ranked highest by Combes and Linnemer (2003). In cases where this approach leads to two or more national journals sharing first place, we pick the journal where central bank researchers from that country publish the largest number of papers. We then assign the highest possible ranking to those national journals.[10] This means, for instance, that the *Canadian Journal of Economics* is ranked equal with the *American Economic Review* in this robustness exercise. Table 5e of Appendix A shows the ranking of central banks based on this approach.

The ranking of central banks is not much affected by this change, with two exceptions. First, assuming that the *Spanish Economic Review* has the same quality as the *American Economic Review* implies that the ranking of the Bank of Spain improves significantly. Second, the ranking of the De Nederlandsche Bank is significantly improved by assuming that *De Economist* is a top-ranking journal.

When considering the 1999–2003 period to account for the creation of the ECB (Table 5a), we find that the ECB ranks fourth in raw publications with 141, behind the Banca d'Italia and ahead of the Chicago Fed. Having a quality index of 0.25, the ECB enters the top 15 at sixth place when quality adjustments are made for the number of co-authors and pages, and it is in seventh place when the index is applied simply to the raw article count.

Our results concerning the number of publications by European central banks are similar to those reported by Jondeau and Pagès (2003). For instance, according to Jondeau and Pagès, the four best central banks based on the unadjusted total number of *EconLit* publications are

[10] The journals that were assigned a "national weight" are as follows: *Annales d'Economie et de Statistique*, *Canadian Journal of Economics*, *De Economist*, *Economia* (Portuguese Catholic University), *Economic and Social Review*, *Economic Record*, *Ekonomiska Samfundets Tidskrift*, *Greek Economic Review*, *Investigaciones Economicas*, *Jahrbucher fur Nationalokonomie und Statistik*, *Kyklos*, *Nationaløkonomisk Tidsskrift*, *New Zealand Economic Papers*, *Politica Economica*, *Swedish Economic Policy Review*, *Tijdschrift voor Economie en Management*, *Weltwirtschaftliches Archiv/Review of World Economics*, and *Zeitschrift fur Betriebswirtschaft*.

(from first to fourth place): the Bank of Italy, the Bank of England, the Bank of France, and the Bank of Spain. Our ranking is the same, except that the Bank of France is fourth and the Bank of Spain is third. This discrepancy could be explained by the fact that Jondeau and Pagès's sample covers 1990–2002, while ours covers 1990–2003.

3.3 Journal publications per researcher

Table 6a lists our data based on the average number of journal articles published per researcher in each of the central banks over the period 1999–2003. Two cases are shown: one based on our unadjusted output data and another based on our output data adjusted for the number of co-authors and the quality of journals. The number of researchers in each central bank corresponds to the number of employees who spend at least 50 per cent of their time performing research. We emphasize the 1999–2003 period because data are missing on the number of researchers in some central banks for a longer sample period (particularly for the ECB, whose activities began in 1999).[11]

It is interesting to note that the ranking based on the unadjusted number of articles published shows similarities with the ranking in Table 5a. In particular, most U.S. Fed banks, the ECB, the Bank of England, and the Bank of Spain rank relatively highly in both tables. Still, marked differences can be noted concerning smaller central banks, such as the Bank of Greece, the Schweizerische Nationalbank, and the Danmarks Nationalbank. These are much better ranked when average output per researcher is considered, instead of total output. On the contrary, the Federal Reserve Bank of New York, the Bank of Italy, and the Federal Reserve Bank of Atlanta rank lower when output per researcher is used, instead of total output.

The Federal Reserve Bank of Minneapolis leads the ranking based on adjusted data. In general, adjusting for journal quality tends to push U.S. institutions higher in the rankings.

[11] Other productivity rankings done by the authors reveal that focusing on the number of pages published or not adjusting for the number of co-authors lead to the same conclusions.

Table 6b shows that our results based on the adjusted number of articles published change when the number of PhDs or the number of authors of papers are used to approximate research inputs, instead of the number of researchers based on our definition. Not surprisingly, central banks that have a high ratio of PhDs to researchers in Table 1d, particularly the BoG, the Bank of Greece, the Bank of England, and the Bank of Sweden, rank much lower when the number of PhDs is used as a proxy for the number of researchers. Central banks from Ireland, France, and Australia rank much higher. The Swiss National Bank and the Boston Fed rank much better when the number of authors is used to approximate the number of researchers.

4. Policy Relevance

In this section, we provide our data on the policy relevance of research based on citations in BIS documents and citations in U.S. Federal Reserve System documents.

Table 7a in Appendix A reports the results of our BIS citation search. We have compiled 890 citations over the period 1999 to 2003. This ranking is constructed based solely on the citations from central bank internal publications—working papers or proprietary policy documents such as monetary policy reports or economic reviews. They therefore do not comprise the publications of central bank economists in academic journals. As a result, it is of particular interest to compare rankings based on citations at the BIS with the one based on raw working paper output in Table 2.

Relative to their output of working papers, a number of central banks are cited disproportionately more, and others disproportionately less. Among the central banks that have increased by more than 10 positions relative to Table 2 are the Boston Fed, the New York Fed, and the Reserve Bank of New Zealand. Notable downward movements are observed for the De Nederlandsche Bank, the Bank of Finland, and the Bank of Italy.

Since the number of citations in BIS publications is one of our main measures for policy relevance of central banks' research output, and because the number of publications in journals is our main gauge of the scientific quality of that output, it is also interesting to compare rankings

based on citations with rankings based on publications in journals. For this we use the ranking based on journal publications (adjusted for quality and number of co-authors) shown in Table 5c. Central banks showing a marked improvement in the citation-based ranking are the Bank of Japan, the Reserve Bank of Australia, and the Reserve Bank of New Zealand. The Bank of Canada is an interesting case, with a high ranking both in terms of working papers published and the number of citations in BIS publications, but a much lower ranking in terms of journal publications. The Federal Reserve Bank of Minneapolis shows the opposite, with a high ranking for the number of publications but much lower rankings both in terms of the number of working papers and the number of citations. Nevertheless, many central banks, including the ECB, the Bank of England, and most U.S. Feds, are highly ranked both in terms of journal publications and citations in BIS publications.

Table 7b shows the number of citations divided by the number of researchers in central banks (based on the 50 per cent plus definition). The rankings of some central banks improve markedly by this measure in comparison with those based on the number of journal publications per researcher (Table 6a). This is particularly the case for the Reserve Bank of New Zealand and the Reserve Bank of Australia. As before, many of the central banks with a high ranking by one measure also rank highly by the other measure.[12]

The central banks of Australia, Ireland, Japan, and the United States have websites that are conducive to citation searches. However, only searches on the websites of the U.S. Federal Reserve institutions provide a suitable sample from which to construct rankings. To remove the home-country bias, we exclude the citations of the host country when compiling the data. Results of a citation search on the U.S. Federal Reserve websites are reported on the right-hand side of Tables 7a and b. These results are very similar to those based on citations at the BIS, which seems to suggest that our conclusions based on BIS citations are somewhat robust.

As stated earlier, we expect a positive correlation between policy relevance and citations in the publications of an international policy-relevant organization. However, policy relevance

[12] A possible bias in the calculation of the number of citations per central bank researchers may be introduced by the fact that we do not exclude central bank documents that have been written by non-central bank researchers from the analysis. However, an informal examination of the results indicates that this does not affect our conclusions.

itself may also be a function of the current issues that dominate debates on the world economy, and the relative impact of each country's economic activity on world economic conditions. Furthermore, some institutions publish widely circulated policy documents that can garner more citations than working papers. Each U.S. Federal Reserve Bank, for instance, publishes its own economic review. Taken together, this can help explain the high number of citations for the United States, Europe, and Japan.

5. Determinants of Research Output

In this section we analyze the factors that can help explain the rankings of research output. A myriad of variables are involved in the production functions of central banks, such as the quantity and quality of labour, computing resources, data availability, library resources, and support staff. It is difficult to measure the magnitude of all these ancillary resources over time for all central banks; they are beyond the scope of this paper. As a result, the productivity measures described herein are necessarily imperfect. Nevertheless, we do possess measures of the key factor of production, namely the number of researchers.

In addition to labour, we can examine the effects of some other measurable factors on published output:

- Production of working papers: Working papers are usually published to generate feedback on work in progress; does this translate into a higher volume of published work?

- Policy relevance of an institution's research output: Does producing policy-relevant research increase an institution's success in publishing its work?

- Collaboration with external partners: Does collaborating with external specialists increase an institution's amount of published research output?

- Size: Is there a negative relationship between the number of researchers in a central bank and their average product, as Eijffinger, de Haan, and Koedijk (2002) claim?

- Number of employees with a PhD: Does a higher ratio of PhDs to the number of researchers lead to higher productivity?

In the remainder of this section, we examine the impact of each of these variables on output. Because we have relatively few time-series observations at our disposal, it is difficult to test formal hypotheses related to causation; neverthless, the simple correlations described should prove informative.

5.1 Labour

Tables 8a through d in Appendix A show results of the following regression for each country:

$$q_{k,t} = \alpha + \beta n_{k,t} + \varepsilon_t, \qquad (6)$$

where $q_{k,t}$ is as defined in Tables 5a through d; namely, the raw output of journal articles and various measures that correct for journal quality, co-authors, and page count for central bank k at time t. Meanwhile, $n_{k,t}$ represents our two survey proxies for the number of researchers in the institution: the number of individuals who spend at least 50 per cent of their time conducting economic research (from Table 1a) and the number of PhDs in the institution (Table 1b). The parameter β therefore represents the marginal product of each institution's researchers. Alternatively, we can include both variables simultaneously, in which case the number of PhDs would represent a measure of the quality of the researchers, the motivation being that PhDs follow developments in the literature more closely, and are trained to perform original research.

Table 8a provides estimates of this simple equation for countries that have supplied the required data on inputs. Parameters are estimated for each country separately using ordinary least squares.[13] With few exceptions, we find that the marginal product of economic researchers at all institutions is positive using either input proxy. Given the relatively small (14 or fewer) number

[13] We also estimate the parameters using a panel data set; the estimates are qualitatively similar.

of observations in our sample, however, the parameter is significantly different from zero in slightly less than half of the institutions.

According to marginal product, the ECB is ranked highest, although its estimate is computed using only six annual observations. The San Francisco Fed is the only other institution with a marginal product greater than 2.0 using the 50 per cent definition, although it is statistically insignificant due to the lack of variation in the input data that it supplied. The institutions with the highest statistically significant measures of marginal output are the St. Louis Fed (1.72), Banque de France (1.20), Chicago Fed (1.07), and Bank of England (1.03). Using PhDs as research inputs, we find that the rankings are relatively unchanged for the top institutions, although notable movements are experienced by the Minneapolis Fed (going from 17th to 8th) and the Bank of England (6th to 20th).

The Bank of Canada places 22nd in terms of marginal product using the 50 per cent measure, and 18th in terms of the number of PhDs. The estimated parameters are relatively similar, however (0.18 and 0.31, respectively), indicating that the institution has to add about five researchers (or three PhDs) to boost its research output in academic journals by one paper per year.

When the output is adjusted for quality, we find that the San Francisco Fed and ECB tend to have the highest marginal product, followed by a number of other U.S. Federal Reserve banks.

It is interesting to note that for some central banks, such as the Chicago Fed, the average product per researcher (0.89 in Table 6a) is very similar to the corresponding estimated marginal product (1.07 in Table 8a). If labour is the only variable input, then equality of the marginal and average yearly product indicates that the average output has attained its maximum; i.e., hiring additional researchers at the Chicago Fed will not increase the average yearly output of published papers. Instead, average product increases would have to be attained through other means, such as higher capital investments (e.g., computing infrastructure), efficiency gains (e.g., a greater degree of research specialization), or more experienced researchers.

5.2 Working papers

To determine the extent of the link between working papers and published output, we plot in Figures 1 and 2 the relationships between total journal articles and working papers (Figure 1) and journal articles and working papers excluding external researchers (Figure 2). A central bank that publishes a high volume of papers written by external researchers will not normally be credited with a journal publication if the working paper is subsequently published in a journal, since the author's affiliation will not be with the central bank.

The 45-degree lines in Figures 1 and 2 help summarize the publication success of central banks: those institutions closest to the 45-degree line publish as many working papers as journal articles, those below it have fewer published journal articles per working paper, and those above it have more. We notice that only a handful of central banks lie above the line.

In addition, we plot two estimated regression lines based on the following equations:

$$q_k = \alpha + \beta_1 WP_k + \varepsilon_k \text{, and} \tag{7}$$

$$q_k = \alpha + \beta_1 WP_k + \beta_2 WP_k^2 + \varepsilon_k \text{,} \tag{8}$$

where the variable q_k represents the number of journal articles published by the kth institution, WP_k is its working paper output, and ε_k is a random disturbance, where k = 1, ..., 34. The squared working paper output is included as an additional regressor to test whether this relationship exhibits increasing, decreasing, or constant returns to scale.

The results show that working papers are a significant coincident indicator of published output, since there is, not surprisingly, a significant positive relationship between the two variables. In Table 9a, the correlations between working papers and various output measures are found to be in the vicinity of +0.50. What is perhaps somewhat surprising is that the relationship exhibits increasing returns to scale, indicating that increases in working paper output can yield a marginally higher number of published journal articles. However, this is largely attributed to the

BoG, which is an outlier; removing this institution from the sample yields a more linear relationship.

5.3 Policy relevance

By developing separate measures for scientific quality and policy relevance, we do not mean to imply that a trade-off exists between the two. In fact, our expectation is that these two aspects of research quality would tend to reinforce each other. Papers with good scientific quality are likely to be more useful for policy-makers than lower-quality papers. Also, we expect that policy relevance is a plus for publications in top journals.

We assess these expectations by examining the relationship between our ranking of central banks based on the number of quality-adjusted publications in journals per researcher (right-hand column of Table 7a) with the ranking based on the number of citations of working papers in BIS publications per researcher (Table 8b). The result, shown in Figure 3, is consistent with our expectations. There is, in general, no trade-off between scientific quality and policy relevance. They are positively, but not perfectly, correlated.

The correlation between policy relevance and output is around +0.60 (Table 9a). This shows that there is a strong, positive, yet imperfect, relationship between the research output of central banks and its policy relevance.

5.4 Research collaboration

Are institutions that collaborate extensively with external research partners more productive than those that collaborate less? Figure 4a plots the relationship between the rankings for collaboration ratios on working papers (shown in Table 3) and the average product of researchers (adjusted for the number of co-authors and the quality of journals); Figure 4b shows the relationship between the rankings of external collaborations and the number of citations by BIS publications per researcher.

We find that, in general, there is a very weak positive relationship between external collaboration and the number of journal publications per researcher. The correlations between collaboration and output measures (Table 9a) are just slightly above zero. This indicates that an effort on the part of central bankers to collaborate with external researchers will have a marginal impact on journal publications. However, such partnerships most likely result in the importing of fresh ideas, which cannot readily be proxied by our data. Furthermore, there does not seem to be a significant relationship between partnerships and the number of citations per researcher. Perhaps this should not be too surprising. Many of these partnerships are with academics and may lead to research papers that are not immediately useful to policy-makers.

Much more work needs to be done to fully understand the impact of research collaboration on research output. We would expect, in particular, that different types of partnerships bring different results. For instance, partnerships with academics might be of a different nature and have different implications for journal publications and policy relevance than partnerships with fellow central bank researchers. More data would be needed to explore this issue.

5.5 Size

Eijffinger, de Haan, and Koedijk (2002) find that the average product of researchers in European central banks that have a small number of researchers tends to be superior to that of larger ones. Angelini (2003), however, argues that this conclusion reflects problems with the data used by Eijffinger, de Haan, and Koedijk. In their study of research output in European central banks, Jondeau and Pagès (2003) conclude that there is no significant relationship between average product and the number of researchers. We revisit this question with our broader set of data.

Our results are shown in Figures 5a and 5b. Figure 5a shows the relationship between the rankings for the number of researchers and number of journal publications (adjusted for quality and co-authors) per researcher, and Figure 5b shows the relationship between the number of researchers and number of BIS citations per researcher. Our conclusion based on these graphs is

that there is no significant relationship between size and average product in either of these cases. Correlation coefficients between size and different measures of average product (Table 9b) are also all close to zero. Robustness checks, in which we experimented with various input and output definitions, and from which we excluded certain central banks that seemed to be outliers, led to similar conclusions. This is in line with the conclusion of Jondeau and Pagès (2003) for Europe.

5.6 Number of PhDs

In section 5.1 we considered the number of PhDs as a quality adjustment in time-series regression. But can we find cross-sectional evidence of a positive relationship between the number of employees with a PhD and the number of journal publications or the number of BIS citations?

Figure 6a indicates that a high number of PhDs per number of researchers is positively correlated with the average number of publications per researcher. Figure 6b shows that this relationship is weaker when the number of BIS citations is used as the output measure. The correlations regarding the impact of PhDs on average product (Table 9b) are inconclusive.

6. Conclusion

Our first main contribution is to provide a systematic comparison of central bank research output based on publications in refereed journals by researchers from the central banks of Australia, Canada, Israel, Japan, New Zealand, the United States, and Western Europe. In particular, we report various rankings of central banks based on the number of articles published in refereed journals, and we use various approaches to adjust for the number of external co-authors and the quality of the journals. These rankings tend to be dominated by U.S. Federal Reserve banks. The Banca d'Italia, the Bank of England, and the European Central Bank also fare well in most cases. The Bank of Canada is near the middle of the rankings of 34 institutions, a result that is robust to various changes in assumptions and sample periods.

We also provide results on the number of journal publications per researcher based on compiled data on the number of researchers at each central bank. As before, U.S. Federal Reserve banks dominate these rankings. The ECB, the Bank of England, and the Sveriges Riksbank are also top-10 central banks. The Bank of Canada ranks lower by this measure.

Our second main contribution is the proposal of a new quantifiable indicator of policy relevance that can be used to assess the performance of central banks in this area. This indicator is based on the number of citations of central bank working papers in publications of the Bank for International Settlement (BIS) and the U.S. Federal Reserve System. The rankings of some central banks change noticeably when this measure of policy relevance is used. For instance, the Bank of Canada improves to ninth position in total BIS citations. Nevertheless, the data show that most central banks have similar rankings for policy relevance as they do for this measure. In other words, apart from a few exceptions, the same central banks tend to be found at the top and the bottom of both the ranking based on scientific quality and that based on policy relevance. Indeed, based on a preliminary investigation, we find that central banks that rank highly in quality-adjusted output also tend to rank highly in relevance. Thus, although some central banks do better by one measure than the other, there does not necessarily need to be a trade-off between research quality/quantity and relevance. On the contrary, they tend to reinforce each other.

Because there is a lack of detailed data on the factors that determine research output, we do not thoroughly examine the factors that affect the research performance of central banks. We do, however, find preliminary evidence of a very weak positive relationship between partnerships with external researchers and productivity in terms of the number of journal publications. More work would need to be done to determine the types of partnerships that yield the greatest output gains.

Another of our findings is that there is no robust relationship between the number of researchers in a central bank and average product measured either in terms of publications in refereed journals or BIS citations. This result is consistent with that of Jondeau and Pagès (2003) for European central banks, but it goes against the conclusion of Eijffinger, de Haan, and Koedijk (2002) that researchers in smaller central banks tend to be more productive.

We also find that there appears to be much diversity in central bank policies towards publishing working papers. While, in most central banks, researchers publish many more working papers than papers in refereed journals, a number of central banks show just the opposite trend, which suggests that they have very strict publication policies. Still, the number of working papers published seems to be a good contemporaneous indicator of journal publications for most central banks.

More work is needed to improve our understanding of the determinants of research output in central banks. This will require better and more detailed data to measure the number of researchers in central banks (although our main results seem robust to the three measures we consider), to capture factors such as the quality of capital and labour used in producing research, as well as the quality of research management.

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Table 1a: Number of Researchers, Survey, 1990-2003

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total	Average
1	Federal Reserve Bank of New York									89	85	77	82	74	75	482	80.3
2	Board of Governors of the FRS	41	41	41	41	41	41	41	41	41	41	41	41	41	41	574	41.0
3	Banca d'Italia	28	29	30	33	34	34	36	41	42	42	44	46	49	49	537	38.4
4	Federal Reserve Bank of Atlanta	27	26	29	28	28	28	32	32	35	36	32	34	36	37	440	31.4
5	Bank of Israel	31	25	32	29	27	29	28	26	29	29	29	26	25	27	392	28.0
6	Bank of Canada	23	22	20	22	22	19	22	23	28	29	25	29	43	42	369	26.4
7	Bank of England	10.5	10.7	9.6	11.8	12	16.4	20.8	23.9	27.5	28.7	36.1	40	47	49.7	344.6	24.6
8	Bank of Finland	X	X	X	X	X	X	X	X	X	19	23	26	26	26	120	24.0
9	Federal Reserve Bank of Chicago	X	13.4	15.4	17.4	18.4	19.4	23.4	25.4	23.4	23.4	25.4	23.4	27	30	285.4	22.0
10	Banque de France	18	22	22	22	18	20	20	22.5	23	23	23.5	23.5	22.5	24.5	304.5	21.8
11	European Central Bank	X	X	X	X	X	X	X	X	12	18	22	23	23	25	123	20.5
12	Federal Reserve Bank of Minneapolis	21	23	23	23	23	25	23	18	19	18	21	17	16	14	284	20.3
13	Federal Reserve Bank of Cleveland	19	20	20	18	17	20	16	15	14	16	17	16	17	17	242	17.3
14	Federal Reserve Bank of Dallas	X	X	X	X	X	X	X	X	X	X	X	X	X	17	17	17.0
15	Federal Reserve Bank of Boston	15	15	16	17	16	17	17	19	20	20	18	15	14	17	236	16.9
16	Federal Reserve Bank of Richmond	17	16	15	17	16	14	15	14	15	15	16	18	17	16	221	15.8
17	Federal Reserve Bank of St. Louis	10	13	12	14	16	16	16	16	16	17	16	18	18	19	217	15.5
18	De Nederlandsche Bank	9	10	11	11	12	12	13	13	15	16	17	17	20	19	195	13.9
19	Banco de Portugal	10	9	12	15	12	16	15	12	12	10	14	14	16	17	184	13.1
20	Federal Reserve Bank of Philadelphia	13	12	12	13	12	12	14	14	12	13	14	14	11	15	181	12.9
21	Banco de Espana	5	10	12	13	14	13	12	13	14	14	13	12	13	13	171	12.2
22	Reserve Bank of Australia	7	9	10	13	16	10	10	10	13	10	10	13	11	15	157	11.2
23	Deutsche Bundesbank	X	X	X	X	3	4	8	5	8	11	9	13	16	16	93	9.3
24	Schweizerische Nationalbank	X	X	X	X	X	6	6	6	6	8	9	9	11	12	73	8.1
25	Federal Reserve Bank of San Francisco	8	8	8	8	8	8	8	8	8	8	8	8	8.5	9	113.5	8.1
26	Central Bank of Ireland	5	6	7	8	8	7	7	8	8	9	7	11	12	10	113	8.1
27	Federal Reserve Bank of Kansas City	5	4	4	6	7	7	9	7	10	9	9	11	10	10	108	7.7
28	Sveriges Riksbank	X	X	X	X	X	X	X	3	4	6	6	8	10	12	49	7.0
29	National Bank of Belgium	3	6	6	6	5	5	5	4	4	4	7	7	9	9	80	5.7
30	Reserve Bank of New Zealand	X	X	X	X	X	X	6	6	6	5	6	5	5	6	45	5.6
31	Danmarks Nationalbank	1	1	1	1	1	1	1	1	1	1	2	2.5	3.5	5	23	1.6
32	Bank of Greece	0	0	0	0	0	0	0	0	0	0	0	0	2	2	4	0.3
33	Bank of Japan	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
34	Oesterreichische Nationalbank	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Total	327	351	368	387	386	400	424	42.	555	584	597	622	654	696	6778	

Table 1b: Number of PhDs, Survey, 1990-2003

	Central Bank	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total	Average
1	Board of Governors of the FRS	210	210	210	210	210	210	210	210	210	210	210	210	210	210	2940	210.0
2	Bank of England	22	27	27	28	28	33	38	41	41	46	51	66	70	74	592	42.3
3	Banca d'Italia	12	14	15	16	16	21	27	34	34	38	41	48	50	51	417	29.8
4	Bank of Canada	12	12	14	18	19	21	20	26	27	29	29	29	36	37	329	23.5
5	Federal Reserve Bank of New York	X	X	X	X	X	X	X	X	61	57	48	52	44	48	310	51.7
6	De Nederlandsche Bank	6	10	13	15	17	19	20	20	27	26	27	28	31	32	291	20.8
7	Federal Reserve Bank of Chicago	X	13.4	15.4	17.4	18.4	19.4	23.4	25.4	23.4	23.4	25.4	23.4	27	30	285	22.0
8	Federal Reserve Bank of San Francisco	19	19	19	19	19	19	19	19	19	19	19	19	20	21	269	19.2
9	Federal Reserve Bank of Atlanta	17	15	17	16	17	15	18	17	19	19	17	18	20	21	246	17.6
10	Sveriges Riksbank	X	X	X	X	10	10	17	17	18	25	26	32	37	40	232	23.2
11	Bank of Finland	7	6	7	7	10	12	18	19	21	25	22	27	25	23	229	16.4
12	Federal Reserve Bank of Cleveland	18	19	19	17	16	19	15	14	13	15	16	15	16	16	228	16.3
13	Federal Reserve Bank of Kansas City	15	14	13	17	18	17	18	15	18	17	15	18	16	16	227	16.2
14	Federal Reserve Bank of Boston	14	14	15	16	15	16	16	18	19	19	17	14	13	16	222	15.9
15	Federal Reserve Bank of Richmond	18	17	15	17	16	14	14	13	14	14	15	17	16	15	215	15.4
16	Federal Reserve Bank of St. Louis	9	12	11	13	16	16	16	16	16	17	16	18	18	19	213	15.2
17	Federal Reserve Bank of Philadelphia	15	14	14	15	14	14	16	16	14	15	16	15	12	16	206	14.7
18	Banco de Espana	8	8	11	12	13	12	13	15	16	17	18	17	18	17	195	13.9
19	Bank of Israel	14	9	13	13	14	12	14	14	14	13	13	13	12	11	179	12.8
20	National Bank of Belgium	8	8	8	8	8	9	9	10	11	12	14	17	16	15	153	10.9
21	Banque de France	8	11	10	11	9	11	12	10	10	11	11	12	12	12	150	10.7
22	Banco de Portugal	5	5	8	10	7	12	11	8	8	7	12	12	13	14	132	9.4
23	Federal Reserve Bank of Minneapolis	11	11	11	11	11	12	11	10	10	9	8	6	6	5	132	9.4
24	European Central Bank	X	X	X	X	X	X	X	X	12	18	22	23	23	25	123	20.5
25	Reserve Bank of New Zealand	7	7	7	7	7	7	7	7	7	7	7	7	7	7	98	7.0
26	Schweizerische Nationalbank	X	X	X	X	X	X	X	X	X	X	X	X	X	72	72	72.0
27	Deutsche Bundesbank	X	X	X	X	1	3	7	4	4	8	7	9	12	12	67	6.7
28	Reserve Bank of Australia	2	2	3	4	4	4	3	4	6	4	6	8	8	7	65	4.6
29	Central Bank of Ireland	2	2	2	2	2	2	2	2	2	2	2	4	6	5	37	2.6
30	Bank of Greece	X	X	X	X	X	X	X	X	X	X	X	X	X	29	29	29.0
31	Danmarks Nationalbank	1	1	0	0	0	0	0	1	1	1	2	5	6	7	25	1.8
32	Federal Reserve Bank of Dallas	X	X	X	X	X	X	X	X	X	X	X	X	X	20	20	20.0
33	Bank of Japan	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
34	Oesterreichische Nationalbank	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Total	460	480	497	519	535	559	594	605	695	723	732	782	800	943	8928	

Table 1c: Number of Staff with at Least One Journal Article or Working Paper, 1999-2003

	Central Bank	1999	2000	2001	2002	2003	1999-2003	Average
1	Board of Governors of the FRS	117	103	91	113	110	251	106.8
2	European Central Bank	21	34	65	86	95	170	60.2
3	Banca d'Italia	62	56	70	48	47	149	56.6
4	Bank of Canada	36	34	36	53	54	131	42.6
5	Bank of England	30	39	39	50	63	128	44.2
6	Bank of Japan	32	57	41	38	27	127	39.0
7	Bank of Finland	41	31	40	33	43	112	37.6
8	Banco de Espana	30	36	35	43	46	102	38.0
9	De Nederlandsche Bank	17	36	45	52	45	93	39.0
10	Federal Reserve Bank of New York	45	34	40	32	29	82	36.0
11	Federal Reserve Bank of Chicago	29	36	41	39	43	72	37.6
12	Reserve Bank of Australia	20	16	16	16	27	65	19.0
13	Federal Reserve Bank of Minneapolis	19	26	23	25	26	52	23.8
14	Federal Reserve Bank of Atlanta	17	22	25	26	23	50	22.6
15	Banque de France	17	19	20	25	14	50	19.0
16	Deutsche Bundesbank	2	9	16	22	19	46	13.6
17	Federal Reserve Bank of St. Louis	22	24	23	25	33	43	25.4
18	Federal Reserve Bank of San Francisco	18	16	26	20	18	41	19.6
19	Federal Reserve Bank of Dallas	22	16	15	15	21	41	17.8
20	Federal Reserve Bank of Cleveland	20	20	23	17	17	40	19.4
21	Bank of Israel	7	17	12	10	18	39	12.8
22	Federal Reserve Bank of Philadelphia	17	13	17	23	23	38	18.6
23	Sveriges Riksbank	16	19	16	14	16	38	16.2
24	Banco de Portugal	8	9	11	17	19	38	12.8
25	Federal Reserve Bank of Kansas City	10	10	15	20	14	36	13.8
26	Oesterreichische Nationalbank	6	7	10	20	10	31	10.6
27	Reserve Bank of New Zealand	10	14	11	9	7	31	10.2
28	National Bank of Belgium	2	13	9	6	15	30	9.0
29	Federal Reserve Bank of Richmond	11	14	13	11	14	27	12.6
30	Federal Reserve Bank of Boston	16	6	10	9	10	27	10.2
31	Bank of Greece	6	9	9	6	13	21	8.6
32	Schweizerische Nationalbank	6	8	9	8	6	19	7.4
33	Central Bank of Ireland	5	7	5	6	6	15	5.8
34	Danmarks Nationalbank	3	0	1	8	3	10	3.0
	Total	740	810	878	945	974	2245	

Table 1d: Ratios, PhD/Researcher and Researchers (Articles or Working Papers) / Researchers (Survey), per year, 1999-2003

Central Bank	1999		2000		2001		2002		2003	
	PhD/ Res	ArtWP/Res	PhD/ Res	ArtWP/Res	PhD/ Res	ArtWP/Res	PhD/ Res	ArtWP/Res	PhD/ Res	ArtWP/Res
Banca d'Italia	0.90	1.48	0.93	1.27	1.04	1.52	1.02	0.98	1.04	0.96
Banco de Espana	1.21	2.14	1.38	2.77	1.42	2.92	1.38	3.31	1.31	3.54
Banco de Portugal	0.70	0.80	0.86	0.64	0.86	0.79	0.81	1.06	0.82	1.12
Bank of Canada	1.00	1.24	1.16	1.36	1.00	1.24	0.84	1.23	0.88	1.29
Bank of England	1.61	1.05	1.41	1.08	1.65	0.97	1.49	1.06	1.49	1.27
Bank of Finland	1.32	2.16	0.96	1.35	1.04	1.54	0.96	1.27	0.88	1.65
Bank of Greece	X	X	X	X	X	X	0.00	3.00	14.50	6.50
Bank of Israel	0.45	0.24	0.45	0.59	0.50	0.46	0.48	0.40	0.41	0.67
Bank of Japan	X	X	X	X	X	X	X	X	X	X
Banque de France	0.48	0.74	0.47	0.81	0.51	0.85	0.53	1.11	0.49	0.57
Board of Governors of the FRS	5.12	2.85	5.12	2.51	5.12	2.22	5.12	2.76	5.12	2.68
Central Bank of Ireland	0.22	0.56	0.29	1.00	0.36	0.45	0.50	0.50	0.50	0.60
Danmarks Nationalbank	1.00	3.00	1.00	0.00	2.00	0.40	1.71	2.29	1.40	0.60
De Nederlandsche Bank	1.63	1.06	1.59	2.12	1.65	2.65	1.55	2.60	1.68	2.37
Deutsche Bundesbank	0.73	0.18	0.78	1.00	0.69	1.23	0.75	1.38	0.75	1.19
European Central Bank	1.00	1.17	1.00	1.55	1.00	2.83	1.00	3.74	1.00	3.80
Federal Reserve Bank of Atlanta	0.53	0.47	0.53	0.69	0.53	0.74	0.56	0.72	0.57	0.62
Federal Reserve Bank of Boston	0.95	0.80	0.94	0.33	0.93	0.67	0.93	0.64	0.94	0.59
Federal Reserve Bank of Chicago	1.00	1.24	1.00	1.42	1.00	1.75	1.00	1.44	1.00	1.43
Federal Reserve Bank of Cleveland	0.94	1.25	0.94	1.18	0.94	1.44	0.94	1.00	0.94	1.00
Federal Reserve Bank of Dallas	X	X	X	X	X	X	X	X	1.18	1.24
Federal Reserve Bank of Kansas City	1.89	1.11	1.67	1.11	1.64	1.36	1.60	2.00	1.60	1.40
Federal Reserve Bank of Minneapolis	0.50	1.06	0.38	1.24	0.35	1.35	0.38	1.56	0.36	1.86
Federal Reserve Bank of New York	0.67	0.53	0.62	0.44	0.63	0.49	0.59	0.43	0.64	0.39
Federal Reserve Bank of Philadelphia	1.15	1.31	1.14	0.93	1.07	1.21	1.09	2.09	1.07	1.53
Federal Reserve Bank of Richmond	0.93	0.73	0.94	0.88	0.94	0.72	0.94	0.65	0.94	0.88
Federal Reserve Bank of San Francisco	2.38	2.25	2.38	2.00	2.38	3.25	2.35	2.35	2.33	2.00
Federal Reserve Bank of St. Louis	1.00	1.29	1.00	1.50	1.00	1.28	1.00	1.39	1.00	1.74
National Bank of Belgium	3.00	0.50	2.00	1.86	2.43	1.29	1.78	0.67	1.67	1.67
Oesterreichische Nationalbank	X	X	X	X	X	X	X	X	X	X
Reserve Bank of Australia	0.40	2.00	0.60	1.60	0.62	1.23	0.73	1.45	0.47	1.80
Reserve Bank of New Zealand	1.40	2.00	1.17	2.33	1.40	2.20	1.40	1.80	1.17	1.17
Schweizerische Nationalbank	0.00	0.75	0.00	0.89	0.00	1.00	0.00	0.73	6.00	0.50
Sveriges Riksbank	4.17	2.67	4.33	3.17	4.00	2.00	3.70	1.40	3.33	1.33

Table 2: Working Papers, Output per Year, 1999-2003

Rank	Institution	1999	2000	2001	2002	2003	Total	Avg	Trend
1	Board of Governors of the Federal Reserve System	92	92	84	95	107	470	94.0	3.3
2	European Central Bank	8	33	73	94	98	306	61.2	**24.1***
3	De Nederlandsche Bank	25	42	47	56	53	223	44.6	**7***
4	Bank of Finland	34	41	45	46	57	223	44.6	**5.1***
5	Bank of Japan**	41	64	39	41	27	212	42.4	-5.1
6	Federal Reserve Bank of Chicago	32	40	31	32	47	182	36.4	2.2
7	Bank of Canada	24	24	28	45	47	167	33.4	**6.6***
8	Federal Reserve Bank of St. Louis	23	32	25	32	45	157	31.4	**4.4***
9	Federal Reserve Bank of Atlanta	23	28	27	33	43	154	30.8	**4.5***
10	Banca d'Italia	19	26	49	30	22	146	29.2	1
11	Banco de Espana	29	23	27	30	31	140	28.0	1.1
12	Federal Reserve Bank of San Francisco	21	20	33	36	28	138	27.6	3
13	Federal Reserve Bank of Philadelphia	22	14	23	36	41	136	27.2	**6***
14	Bank of England	16	19	27	20	39	121	24.2	**4.7***
15	Federal Reserve Bank of New York	38	19	28	15	19	119	23.8	-4.2
16	Federal Reserve Bank of Minneapolis	18	28	23	18	32	119	23.8	1.8
17	Federal Reserve Bank of Cleveland	19	17	20	17	22	95	19.0	0.6
18	Sveriges Riksbank	24	20	14	12	13	83	16.6	**-3***
19	Deutsche Bundesbank	X	10	20	31	18	79	19.8	3.5
20	Federal Reserve Bank of Kansas City	13	11	15	15	14	68	13.6	0.6
21	Banco de Portugal	6	6	10	13	19	54	10.8	**3.3***
22	Oesterreichische Nationalbank	3	3	13	28	6	53	10.6	3.1
23	Reserve Bank of Australia	12	10	10	8	12	52	10.4	-0.2
24	Federal Reserve Bank of Richmond	9	12	9	4	17	51	10.2	0.8
25	Banque de France	15	6	9	11	5	46	9.2	-1.5
26	Reserve Bank of New Zealand	10	11	7	8	10	46	9.2	-0.3
27	Federal Reserve Bank of Dallas	14	6	10	6	9	45	9.0	-1
28	Schweizerische Nationalbank	6	14	7	8	7	42	8.4	-0.4
29	National Bank of Belgium	X	12	6	17	6	41	10.3	-0.7
30	Federal Reserve Bank of Boston	12	5	7	8	8	40	8.0	-0.5
31	Bank of Israel**	4	10	8	5	10	37	7.4	0.7
32	Central Bank of Ireland	5	5	6	6	9	31	6.2	**0.9***
33	Danmarks Nationalbank	X	X	X	9	2	11	5.5	-7
34	Bank of Greece**	X	X	X	X	8	8	8.0	X
	Total	617	703	780	864	923	3887		**77.3***
	Total excluding ECB	609	670	707	770	825	3581		**53.2***

* Signifies that the time trend parameter is statistically significant.

** Indicates that only working papers published in English were compiled for these institutions.

Table 3: Working Papers, Percentage External Collaboration, 1999-2003

Institution	% of non-CB authors	% wp - no CB affiliation	% of external collaboration
Danmarks Nationalbank	50.00	9.09	45.00
Federal Reserve Bank of Atlanta	47.78	11.69	40.87
Federal Reserve Bank of Cleveland	44.21	10.53	37.65
Federal Reserve Bank of San Francisco	33.88	7.97	28.15
Bank of Greece	28.13	0.00	28.13
Federal Reserve Bank of New York	27.24	0.84	26.62
Federal Reserve Bank of Kansas City	26.23	0.00	26.23
Federal Reserve Bank of Chicago	28.43	3.30	25.99
Oesterreichische Nationalbank	56.13	41.51	25.00
Federal Reserve Bank of St. Louis	25.05	0.64	24.57
Banco de Portugal	31.48	9.26	24.49
Federal Reserve Bank of Dallas	24.44	0.00	24.44
European Central Bank	49.32	33.66	23.61
Central Bank of Ireland	22.58	0.00	22.58
Federal Reserve Bank of Richmond	22.55	0.00	22.55
Federal Reserve Bank of Boston	27.92	7.50	22.07
Federal Reserve Bank of Minneapolis	32.49	13.45	22.01
Federal Reserve Bank of Philadelphia	27.98	8.09	21.64
Board of Governors of the Federal Reserve System	22.35	2.77	20.14
Banque de France	20.51	2.17	18.74
Banco de Espana	22.12	8.57	14.82
Banca d'Italia	18.71	4.79	14.61
Schweizerische Nationalbank	59.13	52.38	14.17
Deutsche Bundesbank	47.49	39.24	13.58
National Bank of Belgium	51.14	43.90	12.90
Bank of Finland	33.93	24.22	12.82
Bank of England	22.18	11.57	11.99
Sveriges Riksbank	38.25	30.12	11.64
Bank of Israel	11.49	0.00	11.49
Bank of Canada	11.73	1.80	10.11
De Nederlandsche Bank	12.29	5.38	7.31
Reserve Bank of New Zealand	19.20	13.04	7.08
Reserve Bank of Australia	7.05	0.00	7.05
Bank of Japan	26.88	22.64	5.48
Total Average	**30.30**	**12.36**	**20.16**

Table 4: Journal Publications, Percentage External Collaboration, 1990-2003 and 1999-2003

	1990-2003		1999-2003	
Rank	Institution	% external collaboration	Institution	% external collaboration
1	Federal Reserve Bank of Atlanta	36.0	National Bank of Belgium	44.4
2	Bank of Israel	32.6	Federal Reserve Bank of Kansas City	37.7
3	Oesterreichische Nationalbank	32.5	Federal Reserve Bank of Dallas	36.5
4	Federal Reserve Bank of Kansas City	30.3	Federal Reserve Bank of Atlanta	35.9
5	Federal Reserve Bank of Chicago	30.0	Federal Reserve Bank of New York	35.4
6	Federal Reserve Bank of St. Louis	29.9	Oesterreichische Nationalbank	32.9
7	Federal Reserve Bank of New York	29.6	Federal Reserve Bank of Chicago	32.2
8	Federal Reserve Bank of Dallas	28.6	Federal Reserve Bank of St. Louis	31.7
9	Federal Reserve Bank of San Francisco	28.2	Reserve Bank of New Zealand	31.5
10	Bank of England	27.9	Federal Reserve Bank of Boston	30.8
11	Bank of Greece	26.5	Bank of Greece	29.4
12	Federal Reserve Bank of Minneapolis	26.1	Bank of England	29.4
13	Federal Reserve Bank of Cleveland	25.0	Federal Reserve Bank of San Francisco	28.9
14	Board of Governors of the Federal Reserve System	24.3	Central Bank of Ireland	27.5
15	Reserve Bank of New Zealand	24.2	Bank of Israel	27.5
16	Sveriges Riksbank	23.5	Bank of Finland	26.4
17	Federal Reserve Bank of Philadelphia	23.3	Federal Reserve Bank of Cleveland	25.4
18	Bank of Japan	23.1	Banco de Espana	25.1
19	Banco de Espana	21.6	Federal Reserve Bank of Philadelphia	25.0
20	National Bank of Belgium	21.1	Sveriges Riksbank	24.3
21	Central Bank of Ireland	20.2	Board of Governors of the Federal Reserve System	24.3
22	Banque de France	19.9	Federal Reserve Bank of Minneapolis	22.2
23	Bank of Canada	19.3	Banco de Portugal	21.4
24	Banco de Portugal	19.0	Reserve Bank of Australia	19.6
25	Federal Reserve Bank of Boston	18.4	Federal Reserve Bank of Richmond	18.8
26	European Central Bank	17.7	Banque de France	18.8
27	Reserve Bank of Australia	16.1	Danmarks Nationalbank	18.8
28	Bank of Finland	16.0	European Central Bank	18.1
29	Federal Reserve Bank of Richmond	15.5	Bank of Canada	16.3
30	De Nederlandsche Bank	15.1	De Nederlandsche Bank	15.8
31	Banca d'Italia	13.2	Deutsche Bundesbank	15.6
32	Deutsche Bundesbank	11.8	Banca d'Italia	15.3
33	Danmarks Nationalbank	10.9	Bank of Japan	14.8
34	Schweizerische Nationalbank	10.3	Schweizerische Nationalbank	12.0

Table 5a: Journal Publications, Total, 1990-2003 and 1999-2003

1990-2003					1999-2003			
Rank	Institution	Number of articles	Trend	% external collaboration	Institution	Number of articles	Trend	% external collaboration
1	Board of Governors of the Federal Reserve System	920	0.61	24.3	Board of Governors of the Federal Reserve System	323	-2.9	24.3
2	Federal Reserve Bank of New York	320	2.64*	29.6	Federal Reserve Bank of New York	175	-3.5	35.4
3	Banca d'Italia	318	1.88*	13.2	Banca d'Italia	163	-2.6	15.3
4	Federal Reserve Bank of Minneapolis	292	-0.11	26.1	European Central Bank	141	5.5*	18.1
5	Bank of England	229	0.80*	27.9	Federal Reserve Bank of Chicago	113	1.2	32.2
6	Federal Reserve Bank of Chicago	222	1.46*	30.0	Bank of England	109	0.6	29.4
7	Federal Reserve Bank of Dallas	177	-0.04	28.6	Federal Reserve Bank of Minneapolis	90	-0.4	22.2
8	Banco de Espana	161	0.57*	21.6	Federal Reserve Bank of Atlanta	79	-0.1	35.9
9	Federal Reserve Bank of Atlanta	159	1.01*	36.0	Federal Reserve Bank of St. Louis	72	-0.3	31.7
10	Federal Reserve Bank of Cleveland	150	0.13	25.0	Banco de Espana	71	1.4	25.1
11	European Central Bank	144	3.05*	17.7	Banque de France	70	-1.1	18.8
12	Federal Reserve Bank of Philadelphia	136	-0.46	23.3	Federal Reserve Bank of Cleveland	59	-1.8	25.4
13	Federal Reserve Bank of San Francisco	134	0.55*	28.2	Federal Reserve Bank of San Francisco	57	0.6	28.9
14	Banque de France	130	0.73*	19.9	De Nederlandsche Bank	55	1.4*	15.8
15	De Nederlandsche Bank	118	0.80*	15.1	Federal Reserve Bank of Dallas	53	0.7	36.5
16	Federal Reserve Bank of St. Louis	118	1.14*	29.9	Bank of Greece	51	-0.2	29.4
17	Federal Reserve Bank of Richmond	102	0.3	15.5	Bank of Finland	46	0.4	26.4
18	Bank of Greece	97	0.81*	26.5	Federal Reserve Bank of Richmond	46	0.8	18.8
19	Bank of Finland	94	0.21	16.0	Bank of Canada	40	0.6	16.3
20	Bank of Canada	87	0.65*	19.3	Federal Reserve Bank of Philadelphia	36	1.0	25.0
21	Federal Reserve Bank of Kansas City	83	0.32	30.3	Oesterreichische Nationalbank	35	0.5	32.9
22	Federal Reserve Bank of Boston	76	0.07	18.4	Sveriges Riksbank	35	-0.8	24.3
23	Schweizerische Nationalbank	71	0.22	10.3	Federal Reserve Bank of Kansas City	34	0.1	37.7
24	Bank of Israel	65	-0.07	32.6	Schweizerische Nationalbank	32	0.4	12.0
25	Reserve Bank of Australia	64	0.11	16.1	Deutsche Bundesbank	30	1.8*	15.6
26	Reserve Bank of New Zealand	53	-0.09	24.2	Reserve Bank of Australia	28	-1.3	19.6
27	Banco de Portugal	51	0.01	19.0	Federal Reserve Bank of Boston	26	-0.7	30.8
28	Sveriges Riksbank	51	0.61	23.5	Bank of Japan	18	-1.4*	14.8
29	Deutsche Bundesbank	48	0.55*	11.8	Reserve Bank of New Zealand	18	-0.8	31.5
30	Oesterreichische Nationalbank	42	0.64*	32.5	Bank of Israel	17	0.5	27.5
31	Central Bank of Ireland	38	0.08	20.2	Central Bank of Ireland	17	0.1	27.5
32	Bank of Japan	31	0.24	23.1	Banco de Portugal	14	0.5	21.4
33	Danmarks Nationalbank	23	-0.02	10.9	Danmarks Nationalbank	8	0.3	18.8
34	National Bank of Belgium	15	0.07	21.1	National Bank of Belgium	6	0.0	44.4

Table 5b: Journal Publications, Quality-Weighted, 1990-2003 and 1999-2003

Rank	Institution	Average quality index 1990-2003	Articles 1990-2003	Institution	Average quality index 1999-2003	Articles 1999-2003
1	Board of Governors of the Federal Reserve System	0.45	415.50	Board of Governors of the Federal Reserve System	0.43	138.33
2	Federal Reserve Bank of Minneapolis	0.67	194.75	Federal Reserve Bank of New York	0.46	79.75
3	Federal Reserve Bank of New York	0.43	138.83	Federal Reserve Bank of Minneapolis	0.64	57.92
4	Federal Reserve Bank of Chicago	0.45	100.75	Federal Reserve Bank of Chicago	0.46	52.25
5	Bank of England	0.34	78.50	Banca d'Italia	0.23	37.92
6	Federal Reserve Bank of Atlanta	0.43	68.00	Bank of England	0.34	36.92
7	Banca d'Italia	0.21	67.50	European Central Bank	0.25	35.58
8	Federal Reserve Bank of Cleveland	0.45	67.25	Federal Reserve Bank of Atlanta	0.43	34.00
9	Federal Reserve Bank of Dallas	0.34	60.00	Federal Reserve Bank of Cleveland	0.50	29.25
10	Federal Reserve Bank of San Francisco	0.44	59.00	Federal Reserve Bank of St. Louis	0.37	26.67
11	Federal Reserve Bank of Philadelphia	0.41	56.08	Federal Reserve Bank of San Francisco	0.39	22.33
12	Federal Reserve Bank of Richmond	0.50	50.83	Federal Reserve Bank of Richmond	0.46	21.33
13	Federal Reserve Bank of St. Louis	0.41	48.50	Federal Reserve Bank of Dallas	0.34	17.92
14	Federal Reserve Bank of Boston	0.49	37.50	Banco de Espana	0.23	16.33
15	Banco de Espana	0.22	36.00	Federal Reserve Bank of Boston	0.58	15.08
16	European Central Bank	0.25	35.83	Banque de France	0.21	14.92
17	Federal Reserve Bank of Kansas City	0.41	34.25	Federal Reserve Bank of Philadelphia	0.40	14.42
18	Banque de France	0.24	31.17	Federal Reserve Bank of Kansas City	0.41	13.83
19	Bank of Canada	0.33	28.42	Bank of Canada	0.31	12.50
20	De Nederlandsche Bank	0.23	26.58	Sveriges Riksbank	0.34	12.00
21	Bank of Israel	0.40	26.00	De Nederlandsche Bank	0.20	11.25
22	Banco de Portugal	0.40	20.42	Bank of Greece	0.20	10.00
23	Bank of Greece	0.21	20.33	Bank of Finland	0.22	10.00
24	Schweizerische Nationalbank	0.26	18.17	Schweizerische Nationalbank	0.28	9.08
25	Bank of Finland	0.19	17.67	Reserve Bank of Australia	0.30	8.33
26	Reserve Bank of Australia	0.26	16.58	Bank of Israel	0.37	6.33
27	Sveriges Riksbank	0.32	16.08	Deutsche Bundesbank	0.21	6.17
28	Reserve Bank of New Zealand	0.21	11.33	Banco de Portugal	0.41	5.75
29	Deutsche Bundesbank	0.19	9.33	Oesterreichische Nationalbank	0.16	5.50
30	Oesterreichische Nationalbank	0.18	7.58	Bank of Japan	0.25	4.58
31	Bank of Japan	0.23	7.08	Central Bank of Ireland	0.23	3.83
32	Central Bank of Ireland	0.18	6.83	Reserve Bank of New Zealand	0.18	3.17
33	Danmarks Nationalbank	0.16	3.67	Danmarks Nationalbank	0.21	1.67
34	National Bank of Belgium	0.18	2.75	National Bank of Belgium	0.18	1.08

Table 5c: Journal Publications, Quality-Weighted, Corrected for Number of Co-Authors, 1990-2003 and 1999-2003

Rank	Institution	Articles 1990-2003	Institution	Articles 1999-2003
1	Board of Governors of the Federal Reserve System	306.49	Board of Governors of the Federal Reserve System	101.92
2	Federal Reserve Bank of Minneapolis	140.76	Federal Reserve Bank of New York	51.15
3	Federal Reserve Bank of New York	96.94	Federal Reserve Bank of Minneapolis	44.71
4	Federal Reserve Bank of Chicago	68.82	Federal Reserve Bank of Chicago	34.17
5	Banca d'Italia	55.17	Banca d'Italia	30.04
6	Bank of England	54.86	European Central Bank	27.07
7	Federal Reserve Bank of Cleveland	49.71	Bank of England	25.08
8	Federal Reserve Bank of Dallas	45.31	Federal Reserve Bank of Cleveland	21.81
9	Federal Reserve Bank of Atlanta	43.07	Federal Reserve Bank of Atlanta	21.00
10	Federal Reserve Bank of Philadelphia	41.81	Federal Reserve Bank of St. Louis	17.26
11	Federal Reserve Bank of Richmond	41.54	Federal Reserve Bank of Richmond	16.33
12	Federal Reserve Bank of San Francisco	40.53	Federal Reserve Bank of San Francisco	15.42
13	Federal Reserve Bank of St. Louis	32.90	Federal Reserve Bank of Dallas	14.28
14	Federal Reserve Bank of Boston	29.71	Banque de France	11.86
15	European Central Bank	27.32	Federal Reserve Bank of Philadelphia	10.42
16	Banco de Espana	24.39	Federal Reserve Bank of Boston	10.31
17	Banque de France	24.60	Banco de Espana	10.13
18	Federal Reserve Bank of Kansas City	23.35	Bank of Canada	10.13
19	Bank of Canada	22.29	Sveriges Riksbank	9.11
20	De Nederlandsche Bank	21.37	De Nederlandsche Bank	8.84
21	Bank of Israel	18.11	Federal Reserve Bank of Kansas City	8.25
22	Banco de Portugal	15.99	Schweizerische Nationalbank	7.72
23	Schweizerische Nationalbank	16.01	Bank of Greece	7.11
24	Bank of Greece	14.83	Bank of Finland	6.99
25	Bank of Finland	13.63	Reserve Bank of Australia	6.38
26	Reserve Bank of Australia	13.38	Deutsche Bundesbank	4.85
27	Sveriges Riksbank	11.83	Bank of Israel	4.64
28	Reserve Bank of New Zealand	8.01	Banco de Portugal	4.50
29	Deutsche Bundesbank	7.93	Bank of Japan	3.85
30	Central Bank of Ireland	5.33	Oesterreichische Nationalbank	3.57
31	Bank of Japan	5.24	Central Bank of Ireland	3.03
32	Oesterreichische Nationalbank	4.63	Reserve Bank of New Zealand	1.96
33	Danmarks Nationalbank	2.96	Danmarks Nationalbank	1.04
34	National Bank of Belgium	1.90	National Bank of Belgium	0.57

Table 5d: Journal Publications, Quality-Weighted, Corrected for Co-Authors and Pages, 1990-2003 and 1999-2003

Rank	Institution	Pages 1990-2003	Institution	Pages 1999-2003
1	Board of Governors of the Federal Reserve System	5877.19	Board of Governors of the Federal Reserve System	2171.15
2	Federal Reserve Bank of Minneapolis	2798.61	Federal Reserve Bank of New York	1046.11
3	Federal Reserve Bank of New York	1882.19	Federal Reserve Bank of Chicago	818.75
4	Federal Reserve Bank of Chicago	1519.39	Federal Reserve Bank of Minneapolis	765.22
5	Banca d'Italia	1208.36	Banca d'Italia	744.54
6	Bank of England	937.68	European Central Bank	568.89
7	Federal Reserve Bank of Atlanta	782.68	Bank of England	508.32
8	Federal Reserve Bank of Cleveland	787.64	Federal Reserve Bank of Atlanta	388.31
9	Federal Reserve Bank of Richmond	779.25	Federal Reserve Bank of Richmond	357.96
10	Federal Reserve Bank of San Francisco	735.78	Federal Reserve Bank of Cleveland	357.71
11	Federal Reserve Bank of Philadelphia	713.97	Federal Reserve Bank of St. Louis	349.18
12	Federal Reserve Bank of Dallas	669.39	Federal Reserve Bank of San Francisco	292.40
13	European Central Bank	572.89	Banque de France	237.85
14	Federal Reserve Bank of Boston	581.21	Federal Reserve Bank of Dallas	235.50
15	Federal Reserve Bank of St. Louis	567.49	Banco de Espana	228.92
16	Banque de France	493.42	Federal Reserve Bank of Philadelphia	215.79
17	Federal Reserve Bank of Kansas City	468.21	Federal Reserve Bank of Kansas City	209.32
18	Banco de Espana	472.94	Federal Reserve Bank of Boston	200.85
19	De Nederlandsche Bank	421.76	Sveriges Riksbank	174.49
20	Bank of Canada	377.19	Bank of Canada	171.90
21	Banco de Portugal	272.72	De Nederlandsche Bank	170.62
22	Bank of Greece	260.85	Schweizerische Nationalbank	145.11
23	Schweizerische Nationalbank	270.07	Bank of Greece	135.07
24	Bank of Israel	280.86	Bank of Finland	135.76
25	Sveriges Riksbank	225.97	Reserve Bank of Australia	101.17
26	Bank of Finland	231.29	Banco de Portugal	73.38
27	Reserve Bank of Australia	196.19	Deutsche Bundesbank	71.39
28	Deutsche Bundesbank	112.01	Oesterreichische Nationalbank	69.71
29	Reserve Bank of New Zealand	112.93	Bank of Israel	63.92
30	Central Bank of Ireland	104.28	Bank of Japan	62.67
31	Oesterreichische Nationalbank	91.96	Central Bank of Ireland	56.67
32	Bank of Japan	81.99	Reserve Bank of New Zealand	29.58
33	Danmarks Nationalbank	58.33	Danmarks Nationalbank	20.33
34	National Bank of Belgium	46.62	National Bank of Belgium	13.70

Table 5e: Journal Publications, National-Weights, Quality-Weighed, Corrected for Number of Co-Authors, 1990-2003

New rank	Institution	Prev rank	Articles 1990-2003	Institution	Prev rank	Articles 1999-2003
1	Board of Governors of the FRS	1	309.4	Board of Governors of the FRS	1	102.33
2	Federal Reserve Bank of Minneapolis	2	142.0	Federal Reserve Bank of New York	2	51.15
3	Federal Reserve Bank of New York	3	98.8	Federal Reserve Bank of Minneapolis	4	45.63
4	Banca d'Italia	5	78.6	Banca d'Italia	5	38.38
5	Federal Reserve Bank of Chicago	4	68.8	Federal Reserve Bank of Chicago	3	34.17
6	Bank of England	6	58.0	European Central Bank	6	30.76
7	Federal Reserve Bank of Cleveland	7	50.0	Bank of England	7	26.72
8	Banco de Espana	16	47.8	Federal Reserve Bank of Cleveland	10	22.08
9	Federal Reserve Bank of Dallas	8	46.0	Federal Reserve Bank of Atlanta	8	21.00
10	De Nederlandsche Bank	20	44.6	Federal Reserve Bank of St. Louis	11	17.72
11	Federal Reserve Bank of Atlanta	9	43.3	Federal Reserve Bank of Richmond	9	16.33
12	Federal Reserve Bank of San Francisco	12	43.3	Federal Reserve Bank of San Francisco	12	16.08
13	Federal Reserve Bank of Philadelphia	10	42.8	Banque de France	13	15.86
14	Federal Reserve Bank of Richmond	11	42.2	Banco de Espana	15	15.32
15	Federal Reserve Bank of St. Louis	13	34.1	Federal Reserve Bank of Dallas	14	14.61
16	Banque de France	17	31.2	De Nederlandsche Bank	21	14.29
17	European Central Bank	15	31.0	Bank of Canada	20	11.13
18	Federal Reserve Bank of Boston	14	30.5	Sveriges Riksbank	19	10.94
19	Bank of Finland	25	27.6	Federal Reserve Bank of Philadelphia	16	10.92
20	Bank of Canada	19	25.0	Federal Reserve Bank of Boston	18	10.31
21	Reserve Bank of Australia	26	24.2	Reserve Bank of Australia	25	9.38
22	Federal Reserve Bank of Kansas City	18	23.3	Schweizerische Nationalbank	22	9.31
23	Banco de Portugal	22	21.5	Federal Reserve Bank of Kansas City	17	8.25
24	Bank of Greece	24	19.2	Bank of Greece	23	7.78
25	Sveriges Riksbank	27	18.7	Bank of Finland	24	7.65
26	Reserve Bank of New Zealand	28	18.4	Deutsche Bundesbank	27	6.26
27	Bank of Israel	21	18.1	Bank of Israel	29	4.64
28	Schweizerische Nationalbank	23	17.9	Banco de Portugal	26	4.50
29	Deutsche Bundesbank	29	11.1	Bank of Japan	30	3.85
30	Bank of Japan	31	6.2	Oesterreichische Nationalbank	33	3.57
31	Central Bank of Ireland	30	5.3	Central Bank of Ireland	31	3.03
32	Oesterreichische Nationalbank	32	4.6	Reserve Bank of New Zealand	32	2.88
33	National Bank of Belgium	34	4.2	Danmarks Nationalbank	33	1.04
34	Danmarks Nationalbank	33	3.0	National Bank of Belgium	34	0.98

Table 6a: Average Product of Researchers, Journal Publications, 1999-2003

		Average output per researcher		Corr. for co-authors, quality-weighted
1	Bank of Greece	1.7000	Federal Reserve Bank of Minneapolis	0.5350
2	Board of Governors of the FRS	1.5756	Board of Governors of the FRS	0.4972
3	Federal Reserve Bank of San Francisco	1.3699	Federal Reserve Bank of San Francisco	0.3688
4	European Central Bank	1.2551	Federal Reserve Bank of Cleveland	0.2664
5	Banco de Espana	1.1016	Federal Reserve Bank of Chicago	0.2632
6	Federal Reserve Bank of Minneapolis	1.0671	Bank of Greece	0.2472
7	Sveriges Riksbank	0.9267	European Central Bank	0.2387
8	Federal Reserve Bank of Chicago	0.8873	Sveriges Riksbank	0.2265
9	Federal Reserve Bank of St. Louis	0.8201	Federal Reserve Bank of Richmond	0.2010
10	Federal Reserve Bank of Dallas	0.7647	Federal Reserve Bank of St. Louis	0.1973
11	Danmarks Nationalbank	0.7314	Federal Reserve Bank of Dallas	0.1822
12	Banca d'Italia	0.7171	Federal Reserve Bank of Kansas City	0.1648
13	Federal Reserve Bank of Cleveland	0.7162	Schweizerische Nationalbank	0.1645
14	Federal Reserve Bank of Kansas City	0.6764	Federal Reserve Bank of Philadelphia	0.1574
15	Reserve Bank of New Zealand	0.6733	Banco de Espana	0.1571
16	Schweizerische Nationalbank	0.6644	Banca d'Italia	0.1311
17	De Nederlandsche Bank	0.6139	Federal Reserve Bank of New York	0.1283
18	Banque de France	0.6024	Bank of England	0.1264
19	Federal Reserve Bank of Richmond	0.5576	Federal Reserve Bank of Boston	0.1235
20	Bank of England	0.5561	Federal Reserve Bank of Atlanta	0.1200
21	Federal Reserve Bank of Philadelphia	0.5483	Reserve Bank of Australia	0.1114
22	Reserve Bank of Australia	0.4981	Banque de France	0.1017
23	Federal Reserve Bank of Atlanta	0.4538	De Nederlandsche Bank	0.0982
24	Federal Reserve Bank of New York	0.4420	Danmarks Nationalbank	0.0743
25	Deutsche Bundesbank	0.4415	Reserve Bank of New Zealand	0.0726
26	Bank of Finland	0.3827	Deutsche Bundesbank	0.0687
27	Central Bank of Ireland	0.3715	Banco de Portugal	0.0658
28	Federal Reserve Bank of Boston	0.3049	Central Bank of Ireland	0.0634
29	Bank of Canada	0.2542	Bank of Canada	0.0612
30	Banco de Portugal	0.1992	Bank of Finland	0.0571
31	National Bank of Belgium	0.1952	Bank of Israel	0.0342
32	Bank of Israel	0.1274	National Bank of Belgium	0.0162
33	Bank of Japan	X	Bank of Japan	X
34	Oesterreichische Nationalbank	X	Oesterreichische Nationalbank	X

Table 6b: Average Product of Researchers, PhDs and Article/WP Authors, Journal Publications, Corrected for Co-Authors and Pages, Quality-weighted, 1999-2003

		Res		PhD		ArtWP
1	Board of Governors of the FRS	10.5910	FRB of Minneapolis	24.4543	FRB of Minneapolis	6.3678
2	FRB of Minneapolis	9.2238	FRB of Chicago	6.3612	FRB of New York	5.7291
3	FRB of San Francisco	6.9982	European Central Bank	5.0056	FRB of Richmond	5.6524
4	FRB of Chicago	6.3612	FRB of Richmond	4.6823	FRB of Chicago	4.3134
5	Bank of Greece	5.5250	FRB of Cleveland	4.6682	FRB of Boston	4.2966
6	European Central Bank	5.0056	FRB of New York	4.1457	Schweizerische Nationalbank	4.1948
7	Sveriges Riksbank	4.3996	FRB of Atlanta	4.1183	Board of Governors of the FRS	4.0911
8	FRB of Richmond	4.3941	Banque de France	4.0971	FRB of Atlanta	3.5945
9	FRB of Cleveland	4.3821	FRB of St. Louis	3.9930	FRB of Cleveland	3.4719
10	FRB of Kansas City	4.1525	Reserve Bank of Australia	3.4615	Bank of Greece	3.1956
11	FRB of St. Louis	3.9930	Banca d'Italia	3.3021	FRB of Kansas City	3.1308
12	Banco de Espana	3.5553	Central Bank of Ireland	3.0899	FRB of San Francisco	3.0564
13	Banca d'Italia	3.2550	FRB of San Francisco	2.9656	FRB of St. Louis	2.7827
14	FRB of Philadelphia	3.2056	FRB of Philadelphia	2.9517	FRB of Dallas	2.7246
15	Schweizerische Nationalbank	3.1782	Banco de Espana	2.6212	Banca d'Italia	2.6388
16	FRB of New York	2.6331	FRB of Boston	2.4916	Banque de France	2.5298
17	Bank of England	2.5189	FRB of Kansas City	2.4631	Bank of England	2.3308
18	FRB of Boston	2.3438	Board of Governors of the FRS	2.0678	FRB of Philadelphia	2.2325
19	FRB of Atlanta	2.2246	FRB of Dallas	1.9639	Sveriges Riksbank	2.1787
20	Banque de France	2.0410	Bank of England	1.6571	European Central Bank	2.0975
21	De Nederlandsche Bank	1.8824	Banco de Portugal	1.3844	Central Bank of Ireland	1.8604
22	Reserve Bank of Australia	1.7226	Deutsche Bundesbank	1.2830	Danmarks Nationalbank	1.4215
23	Danmarks Nationalbank	1.4648	Danmarks Nationalbank	1.2067	Oesterreichische Nationalbank	1.3465
24	Central Bank of Ireland	1.1990	De Nederlandsche Bank	1.1640	Banco de Espana	1.1954
25	Bank of Finland	1.1057	Sveriges Riksbank	1.1130	Banco de Portugal	1.1860
26	Reserve Bank of New Zealand	1.0783	Bank of Finland	1.1055	Reserve Bank of Australia	1.0404
27	Banco de Portugal	1.0723	Bank of Israel	1.0688	Bank of Israel	0.9576
28	Bank of Canada	0.9897	Bank of Canada	1.0383	De Nederlandsche Bank	0.9301
29	Deutsche Bundesbank	0.9466	Bank of Greece	1.0316	Deutsche Bundesbank	0.8124
30	Bank of Israel	0.4751	Reserve Bank of New Zealand	0.8452	Bank of Canada	0.7759
31	FRB of Dallas	0.4621	Schweizerische Nationalbank	0.3681	Bank of Finland	0.7431
32	National Bank of Belgium	0.4064	National Bank of Belgium	0.1911	National Bank of Belgium	0.5681
33	Bank of Japan	X	Bank of Japan	X	Reserve Bank of New Zealand	0.5152
34	Oesterreichische Nationalbank	X	Oesterreichische Nationalbank	X	Bank of Japan	0.3486

Table 7a: Citations by BIS and the Fed, 1999-2003

	Central Bank	BIS citations	Central Bank	Fed citations
1	Board of Governors of the Federal Reserve System	140	Bank of England	86
2	Federal Reserve Bank of New York	104	Bank of Japan	67
3	Bank of England	88	Bank of Canada	61
4	European Central Bank	65	European Central Bank	54
5	Bank of Japan	49	Reserve Bank of New Zealand	25
6	Federal Reserve Bank of St. Louis	47	Banca d'Italia	22
7	Federal Reserve Bank of Chicago	32	Reserve Bank of Australia	20
8	Federal Reserve Bank of Cleveland	31	Deutsche Bundesbank	18
9	Bank of Canada	28	Sveriges Riksbank	15
10	Federal Reserve Bank of Kansas City	28	Bank of Finland	14
11	Federal Reserve Bank of Boston	27	Banco de Espana	8
12	Federal Reserve Bank of San Francisco	25	Banco de Portugal	6
13	Reserve Bank of New Zealand	25	Banque de France	4
14	Reserve Bank of Australia	23	De Nederlandsche Bank	4
15	Federal Reserve Bank of Minneapolis	23	National Bank of Belgium	2
16	Bank of Finland	17	Oesterreichische Nationalbank	2
17	Federal Reserve Bank of Atlanta	17	Bank of Israel	1
18	Banca d'Italia	16	Central Bank of Ireland	1
19	Sveriges Riksbank	16	Bank of Greece	0
20	Deutsche Bundesbank	14	Danmarks Nationalbank	0
21	Banque de France	14	Schweizerische Nationalbank	0
22	Federal Reserve Bank of Philadelphia	12	Board of Governors of the Federal Reserve System	X
23	Federal Reserve Bank of Richmond	10	Federal Reserve Bank of Atlanta	X
24	Federal Reserve Bank of Dallas	8	Federal Reserve Bank of Boston	X
25	Oesterreichische Nationalbank	7	Federal Reserve Bank of Chicago	X
26	Banco de Espana	5	Federal Reserve Bank of Cleveland	X
27	De Nederlandsche Bank	5	Federal Reserve Bank of Dallas	X
28	Schweizerische Nationalbank	4	Federal Reserve Bank of Kansas City	X
29	Danmarks Nationalbank	3	Federal Reserve Bank of Minneapolis	X
30	Banco de Portugal	3	Federal Reserve Bank of New York	X
31	National Bank of Belgium	3	Federal Reserve Bank of Philadelphia	X
32	Central Bank of Ireland	1	Federal Reserve Bank of Richmond	X
33	Bank of Greece	0	Federal Reserve Bank of San Francisco	X
34	Bank of Israel	0	Federal Reserve Bank of St. Louis	X

Table 7b: Citations by BIS and the Fed, per Researcher, 1999-2003

	Central Bank	BIS citations	Central Bank	Fed citations
1	Reserve Bank of New Zealand	0.913	Reserve Bank of New Zealand	0.960
2	Board of Governors of the Federal Reserve System	0.683	European Central Bank	0.470
3	Federal Reserve Bank of San Francisco	0.612	Bank of England	0.436
4	Federal Reserve Bank of Kansas City	0.557	Sveriges Riksbank	0.358
5	European Central Bank	0.545	Bank of Canada	0.357
6	Federal Reserve Bank of St. Louis	0.519	Reserve Bank of Australia	0.350
7	Sveriges Riksbank	0.448	Deutsche Bundesbank	0.281
8	Bank of England	0.423	Banco de Espana	0.121
9	Federal Reserve Bank of Cleveland	0.376	Bank of Finland	0.113
10	Reserve Bank of Australia	0.356	Banca d'Italia	0.094
11	Federal Reserve Bank of Boston	0.326	Banco de Portugal	0.079
12	Federal Reserve Bank of Minneapolis	0.299	National Bank of Belgium	0.051
13	Federal Reserve Bank of New York	0.265	De Nederlandsche Bank	0.046
14	Federal Reserve Bank of Chicago	0.254	Banque de France	0.035
15	Deutsche Bundesbank	0.209	Central Bank of Ireland	0.017
16	Federal Reserve Bank of Philadelphia	0.178	Bank of Israel	0.008
17	Bank of Canada	0.167	Danmarks Nationalbank	0.000
18	Bank of Finland	0.135	Schweizerische Nationalbank	0.000
19	Federal Reserve Bank of Richmond	0.121	Bank of Greece	0.000
20	Banque de France	0.120	Board of Governors of the Federal Reserve System	X
21	Danmarks Nationalbank	0.120	Federal Reserve Bank of Atlanta	X
22	Federal Reserve Bank of Dallas	0.118	Federal Reserve Bank of Boston	X
23	Federal Reserve Bank of Atlanta	0.098	Federal Reserve Bank of Chicago	X
24	Schweizerische Nationalbank	0.090	Federal Reserve Bank of Cleveland	X
25	Banco de Espana	0.077	Federal Reserve Bank of Dallas	X
26	National Bank of Belgium	0.073	Federal Reserve Bank of Kansas City	X
27	Banca d'Italia	0.069	Federal Reserve Bank of Minneapolis	X
28	De Nederlandsche Bank	0.060	Federal Reserve Bank of New York	X
29	Banco de Portugal	0.044	Federal Reserve Bank of Philadelphia	X
30	Central Bank of Ireland	0.020	Federal Reserve Bank of Richmond	X
31	Bank of Greece	0.000	Federal Reserve Bank of San Francisco	X
32	Bank of Israel	0.000	Federal Reserve Bank of St. Louis	X
33	Bank of Japan	X	Bank of Japan	X
34	Oesterreichische Nationalbank	X	Oesterreichische Nationalbank	X

Table 8a: Marginal Product of Researchers/PhDs, Journal Publications, 1990-2003

	Input	Researchers			Input	PhDs		
	Central Bank	α	β	R2	Central Bank	α	β	R2
1	European Central Bank	-27.84	**2.53***	0.83	European Central Bank	-27.84	**2.53***	0.83
2	Federal Reserve Bank of San Francisco	-28.70	2.36	0.14	Federal Reserve Bank of San Francisco	-28.70	2.36	0.14
3	Federal Reserve Bank of St. Louis	-18.28*	**1.72***	0.57	Banque de France	-14.09	**2.18***	0.35
4	Banque de France	-16.88	**1.20***	0.30	Federal Reserve Bank of St. Louis	-14.00*	**1.47***	0.57
5	Federal Reserve Bank of Chicago	-6.59	**1.07***	0.41	Federal Reserve Bank of Atlanta	-13.22	1.40	0.23
6	Bank of England	-3.17	**1.03***	0.36	Federal Reserve Bank of Kansas City	-15.88*	1.35	0.47
7	Federal Reserve Bank of Atlanta	-20.83*	**1.02***	0.57	Federal Reserve Bank of Chicago	-6.59	**1.07***	0.41
8	De Nederlandsche Bank	-5.36	**0.99***	0.41	Federal Reserve Bank of Minneapolis	12.21	0.92	0.13
9	Federal Reserve Bank of Richmond	-8.07	0.97	0.17	Banco de Espana	0.85	**0.76***	0.40
10	Bank of Greece	6.67*	0.92	0.02	Banca d'Italia	5.06	**0.70***	0.65
11	Federal Reserve Bank of Kansas City	-0.57	**0.84***	0.38	Federal Reserve Bank of Boston	-3.54	0.57	0.24
12	Banco de Espana	1.69	0.80	0.20	Central Bank of Ireland	1.43	0.54	0.13
13	Banca d'Italia	-7.38	**0.71***	0.49	Federal Reserve Bank of New York	14.43	0.53	0.23
14	Banco de Portugal	-4.84	**0.65***	0.31	De Nederlandsche Bank	-1.24	**0.47***	0.50
15	Federal Reserve Bank of Boston	-4.11	0.57	0.24	Deutsche Bundesbank	1.18	**0.44***	0.39
16	Federal Reserve Bank of New York	3.35	0.53	0.23	Banco de Portugal	-0.19	0.41	0.17
17	Federal Reserve Bank of Minneapolis	11.27	0.47	0.07	Federal Reserve Bank of Richmond	1.73	0.36	0.04
18	Schweizerische Nationalbank	2.58	0.38	0.18	Bank of Canada	-1.19	**0.31***	0.44
19	Deutsche Bundesbank	0.70	**0.37***	0.43	Bank of Israel	1.77	0.22	0.02
20	Reserve Bank of New Zealand	2.00	0.33	0.01	Bank of England	7.15	**0.22***	0.35
21	Central Bank of Ireland	1.15	0.20	0.04	Sveriges Riksbank	0.94	0.17	0.28
22	Bank of Canada	1.44	0.18	0.12	Bank of Finland	5.11*	0.10	0.05
23	Bank of Finland	1.07	0.17	0.17	Reserve Bank of Australia	4.49*	0.02	0.00
24	Reserve Bank of Australia	2.81	0.16	0.03	National Bank of Belgium	1.05	0.00	0.00
25	Danmarks Nationalbank	1.46*	0.11	0.03	Federal Reserve Bank of Cleveland	16.57*	-0.36	0.05
26	Bank of Israel	2.23	0.09	0.01	Federal Reserve Bank of Philadelphia	25.55	-1.08	0.09
27	National Bank of Belgium	1.03	0.01	0.00	Bank of Greece	X	X	X
28	Federal Reserve Bank of Cleveland	16.93*	-0.36	0.05	Bank of Japan	X	X	X
29	Federal Reserve Bank of Philadelphia	25.21	-1.20	0.12	Board of Governors of the FRS	X	X	X
30	Bank of Japan	X	X	X	Danmarks Nationalbank	X	X	X
31	Board of Governors of the FRS	X	X	X	Federal Reserve Bank of Dallas	X	X	X
32	Federal Reserve Bank of Dallas	X	X	X	Oesterreichische Nationalbank	X	X	X
33	Oesterreichische Nationalbank	X	X	X	Reserve Bank of New Zealand	X	X	X
34	Sveriges Riksbank	X	X	X	Schweizerische Nationalbank	X	X	X
	Total**	-192.57*	**1.06***	0.69	**Total****	-97.64	**0.66***	0.76

Table 8b: Marginal Product of Researchers/PhDs, Journal Publications, Quality-Weighted, 1990-2003

	Input	Researchers			Input	PhDs		
	Central Bank	α	β	R2	**Central Bank**	α	β	R2
1	Federal Reserve Bank of San Francisco	-14.79	1.17	0.09	Federal Reserve Bank of San Francisco	-14.79	1.17	0.09
2	European Central Bank	-9.03*	**0.73***	0.88	European Central Bank	-9.03*	**0.73***	0.88
3	Federal Reserve Bank of St. Louis	-5.72*	**0.59***	0.59	Federal Reserve Bank of Atlanta	-7.46	**0.70***	0.27
4	Reserve Bank of New Zealand	-2.08	0.53	0.11	Federal Reserve Bank of Kansas City	-7.70*	**0.63***	0.42
5	Federal Reserve Bank of Chicago	-2.04	**0.45***	0.40	Federal Reserve Bank of Minneapolis	8.73	0.55	0.10
6	Federal Reserve Bank of New York	-10.97	0.45	0.32	Federal Reserve Bank of St. Louis	-4.33*	**0.51***	0.60
7	Federal Reserve Bank of Atlanta	-9.07*	**0.44***	0.50	Federal Reserve Bank of Chicago	-2.04	**0.45***	0.40
8	Federal Reserve Bank of Kansas City	-0.31	**0.36***	0.28	Federal Reserve Bank of New York	-1.52	0.45	0.32
9	Bank of England	0.01	0.30	0.20	Banque de France	-1.74	0.37	0.26
10	Banco de Portugal	-2.37	**0.29***	0.35	Banco de Portugal	-0.34	0.19	0.21
11	Federal Reserve Bank of Minneapolis	8.89	0.25	0.04	Federal Reserve Bank of Boston	-0.28	0.19	0.06
12	Bank of Greece	1.39*	0.22	0.02	Banca d'Italia	0.18	**0.18***	0.61
13	Banca d'Italia	-3.59	**0.20***	0.52	Central Bank of Ireland	0.05	**0.15***	0.30
14	Federal Reserve Bank of Boston	-0.46	0.19	0.06	Banco de Espana	0.80	0.13	0.12
15	Schweizerische Nationalbank	-0.05	0.18	0.29	Reserve Bank of Australia	0.61	0.12	0.15
16	Banque de France	-1.48	0.17	0.15	Bank of Canada	-0.36	**0.10***	0.44
17	Danmarks Nationalbank	0.01	**0.16***	0.42	Bank of Israel	0.69	0.09	0.03
18	De Nederlandsche Bank	-0.31	0.16	0.20	Deutsche Bundesbank	-0.03	0.09	0.35
19	Bank of Israel	-2.13	0.14	0.15	Sveriges Riksbank	-0.41	**0.08***	0.42
20	Reserve Bank of Australia	-0.06	0.11	0.17	De Nederlandsche Bank	0.40	0.07	0.22
21	Bank of Finland	-1.81	**0.09***	0.22	Bank of England	2.82	0.07	0.21
22	Deutsche Bundesbank	-0.03	0.09	0.35	Bank of Finland	0.45	0.05	0.25
23	Bank of Canada	0.07	0.07	0.20	National Bank of Belgium	0.11	0.01	0.01
24	Central Bank of Ireland	-0.09	0.06	0.13	Federal Reserve Bank of Cleveland	6.27	-0.09	0.01
25	National Bank of Belgium	0.09	0.02	0.02	Federal Reserve Bank of Richmond	6.12	-0.16	0.03
26	Federal Reserve Bank of Richmond	4.08	-0.03	0.00	Federal Reserve Bank of Philadelphia	7.84	-0.26	0.03
27	Banco de Espana	2.94	-0.03	0.00	Bank of Greece	X	X	X
28	Federal Reserve Bank of Cleveland	6.36	-0.09	0.01	Bank of Japan	X	X	X
29	Federal Reserve Bank of Philadelphia	6.93	-0.23	0.02	Board of Governors of the FRS	X	X	X
30	Bank of Japan	X	X	X	Danmarks Nationalbank	X	X	X
31	Board of Governors of the FRS	X	X	X	Federal Reserve Bank of Dallas	X	X	X
32	Federal Reserve Bank of Dallas	X	X	X	Oesterreichische Nationalbank	X	X	X
33	Oesterreichische Nationalbank	X	X	X	Reserve Bank of New Zealand	X	X	X
34	Sveriges Riksbank	X	X	X	Schweizerische Nationalbank	X	X	X
	Total**	-26.28	**0.30***	0.54	**Total****	11.25	**0.16***	0.48

Table 8c: Marginal Product of Researchers/PhDs, Journal Publications, Quality-Weighted, Corrected for Co-Authors, 1990-2003

	Input	Researchers			Input	PhDs		
	Central Bank	α	β	R2	Central Bank	α	β	R2
1	Federal Reserve Bank of San Francisco	-8.82	0.72	0.07	Federal Reserve Bank of San Francisco	-8.82	0.72	0.07
2	European Central Bank	-6.88	**0.56***	0.80	European Central Bank	-6.88	**0.56***	0.80
3	Federal Reserve Bank of St. Louis	-3.25	**0.36***	0.49	Federal Reserve Bank of Kansas City	-6.08*	**0.48***	0.55
4	Federal Reserve Bank of New York	-10.51	0.35	0.47	Federal Reserve Bank of Atlanta	-3.35	0.37	0.15
5	Reserve Bank of New Zealand	-1.33	0.34	0.09	Federal Reserve Bank of New York	-3.10	0.35	0.47
6	Federal Reserve Bank of Atlanta	-5.47	**0.27***	0.40	Federal Reserve Bank of St. Louis	-2.44	**0.31***	0.51
7	Federal Reserve Bank of Chicago	-0.24	**0.25***	0.31	Banque de France	-1.27	0.28	0.18
8	Federal Reserve Bank of Boston	-1.80	0.23	0.10	Federal Reserve Bank of Chicago	-0.24	**0.25***	0.31
9	Banco de Portugal	-1.63	0.21	0.26	Federal Reserve Bank of Boston	-1.57	0.23	0.10
10	Bank of England	0.31	0.19	0.19	Federal Reserve Bank of Minneapolis	8.16*	0.20	0.03
11	Federal Reserve Bank of Kansas City	0.25	0.18	0.17	Central Bank of Ireland	-0.03	**0.15***	0.33
12	Bank of Israel	-3.74	**0.18***	0.37	Banca d'Italia	0.46	**0.14***	0.56
13	Banque de France	-1.54	0.15	0.14	Banco de Portugal	-0.13	0.14	0.15
14	Banca d'Italia	-2.45	**0.15***	0.49	Bank of Israel	-0.11	0.11	0.06
15	De Nederlandsche Bank	0.02	0.11	0.19	Banco de Espana	0.41	0.10	0.17
16	Bank of Greece	1.03*	0.10	0.01	Deutsche Bundesbank	0.17	0.08	0.26
17	Schweizerische Nationalbank	0.44	0.10	0.13	Bank of Canada	-0.31	**0.08***	0.43
18	Bank of Canada	-0.18	0.07	0.25	Sveriges Riksbank	-0.38	**0.07***	0.51
19	Deutsche Bundesbank	0.13	0.06	0.24	Reserve Bank of Australia	0.71	0.05	0.04
20	Reserve Bank of Australia	0.28	0.06	0.08	De Nederlandsche Bank	0.50	0.05	0.21
21	Bank of Finland	-0.98	0.06	0.15	Bank of England	2.08	0.04	0.21
22	Banco de Espana	1.05	0.06	0.03	Bank of Finland	0.63	0.02	0.07
23	Danmarks Nationalbank	0.12	0.06	0.16	National Bank of Belgium	0.15	0.00	0.00
24	Central Bank of Ireland	-0.09	0.05	0.11	Federal Reserve Bank of Richmond	4.60	-0.11	0.02
25	Federal Reserve Bank of Minneapolis	9.23	0.04	0.00	Federal Reserve Bank of Cleveland	6.11	-0.16	0.03
26	National Bank of Belgium	0.13	0.00	0.00	Federal Reserve Bank of Philadelphia	8.21	-0.36	0.09
27	Federal Reserve Bank of Richmond	4.23	-0.08	0.01	Bank of Greece	X	X	X
28	Federal Reserve Bank of Cleveland	6.26	-0.16	0.03	Bank of Japan	X	X	X
29	Federal Reserve Bank of Philadelphia	7.59	-0.36	0.10	Board of Governors of the FRS	X	X	X
30	Bank of Japan	X	X	X	Danmarks Nationalbank	X	X	X
31	Board of Governors of the FRS	X	X	X	Federal Reserve Bank of Dallas	X	X	X
32	Federal Reserve Bank of Dallas	X	X	X	Oesterreichische Nationalbank	X	X	X
33	Oesterreichische Nationalbank	X	X	X	Reserve Bank of New Zealand	X	X	X
34	Sveriges Riksbank	X	X	X	Schweizerische Nationalbank	X	X	X
	Total**	-6.27	**0.19***	0.47	**Total****	18.82	**0.10***	0.40

Table 8d: Marginal Product of Researchers/PhDs, Journal Publications, Quality-Weighted, Corrected for Co-Authors and Pages, 1990-2003

	Input	Researchers			Input	PhDs		
	Central Bank	α	β	R2	**Central Bank**	α	β	R2
1	Federal Reserve Bank of San Francisco	-183.44	14.55	0.09	Federal Reserve Bank of San Francisco	-183.44	14.55	0.09
2	European Central Bank	-147.19	**11.84***	0.92	European Central Bank	-147.19	11.84	0.92
3	Federal Reserve Bank of St. Louis	-85.73*	**8.15***	0.60	Federal Reserve Bank of Kansas City	-143.53*	**10.91***	0.46
4	Bank of England	-73.01*	**7.41***	0.71	Banque de France	-51.85	**8.13***	0.31
5	Federal Reserve Bank of Chicago	-31.55	**6.86***	0.34	Federal Reserve Bank of Minneapolis	125.09	7.93	0.07
6	Reserve Bank of New Zealand	-29.42	6.81	0.16	Federal Reserve Bank of Atlanta	-80.12	7.74	0.15
7	Federal Reserve Bank of Kansas City	-15.32	6.32	0.32	Federal Reserve Bank of St. Louis	-65.51*	**6.97***	0.59
8	Federal Reserve Bank of Boston	-60.85	6.07	0.11	Federal Reserve Bank of Chicago	-31.55	**6.86***	0.34
9	Federal Reserve Bank of Atlanta	-122.64	**5.68***	0.38	Federal Reserve Bank of Boston	-54.78	6.07	0.11
10	Bank of Greece	17.13*	5.25	0.07	Federal Reserve Bank of New York	12.47	5.10	0.37
11	Federal Reserve Bank of New York	-94.70	5.10	0.37	Banca d'Italia	-20.58	**4.22***	0.67
12	Banca d'Italia	-104.48	**4.49***	0.55	Bank of Israel	-25.45	3.56	0.15
13	Banco de Portugal	-28.71	**3.67***	0.28	Banco de Espana	-3.17	2.65	0.25
14	Banque de France	-41.40	3.52	0.16	Banco de Portugal	-2.20	2.30	0.15
15	Bank of Israel	-44.30	2.30	0.14	Deutsche Bundesbank	-0.99	1.77	0.27
16	Federal Reserve Bank of Minneapolis	155.45	2.19	0.01	Reserve Bank of Australia	6.03	1.72	0.16
17	De Nederlandsche Bank	2.43	1.99	0.17	Bank of England	0.13	**1.58***	0.70
18	Reserve Bank of Australia	-3.59	1.57	0.20	Bank of Canada	-9.49	**1.55***	0.51
19	Bank of Canada	-13.45	**1.53***	0.42	Sveriges Riksbank	-5.48	1.18	0.37
20	Bank of Finland	-31.99	**1.44***	0.23	Central Bank of Ireland	3.27	1.08	0.09
21	Deutsche Bundesbank	-2.23	1.41	0.27	De Nederlandsche Bank	11.70	0.89	0.19
22	Danmarks Nationalbank	2.24	1.17	0.05	Bank of Finland	3.65	0.79	0.26
23	Schweizerische Nationalbank	14.74	1.04	0.03	National Bank of Belgium	4.01	-0.06	0.00
24	Banco de Espana	22.08	0.96	0.01	Federal Reserve Bank of Cleveland	64.54	-0.51	0.00
25	Central Bank of Ireland	3.42	0.32	0.02	Federal Reserve Bank of Philadelphia	110.01	-4.01	0.04
26	National Bank of Belgium	3.87	-0.09	0.00	Federal Reserve Bank of Richmond	129.43	-4.80	0.07
27	Federal Reserve Bank of Cleveland	65.05	-0.51	0.00	Bank of Greece	X	X	X
28	Federal Reserve Bank of Richmond	81.19	-1.62	0.01	Bank of Japan	X	X	X
29	Federal Reserve Bank of Philadelphia	78.98	-2.16	0.01	Board of Governors of the FRS	X	X	X
30	Bank of Japan	X	X	X	Danmarks Nationalbank	X	X	X
31	Board of Governors of the FRS	X	X	X	Federal Reserve Bank of Dallas	X	X	X
32	Federal Reserve Bank of Dallas	X	X	X	Oesterreichische Nationalbank	X	X	X
33	Oesterreichische Nationalbank	X	X	X	Reserve Bank of New Zealand	X	X	X
34	Sveriges Riksbank	X	X	X	Schweizerische Nationalbank	X	X	X
	Total**	-1237.2*	**6.17***	0.69	**Total****	-501.82	**3.47***	0.67

Table 9a: Correlation Coefficients between Output Measures and Explanatory Variables

Explanatory variables	Output measures				
	Journal publications (Table 5a)	Quality-weighted (Table 5b)	Quality-weighted + co-authors (Table 5c)	Quality-weighted + co-authors + pages (Table 5d)	Quality-weighted + co-authors + pages + national weights (Table 5e)
Working papers (Table 2)	+0.59	+0.50	+0.51	+0.49	+0.54
Policy relevance (Table 7a)	+0.57	+0.61	+0.61	+0.59	+0.60
Collaboration (Table 4)	+0.01	+0.11	+0.04	+0.03	-0.03

Table 9b: Correlation Coefficients between Average Product Measures and Explanatory Variables

Explanatory variables	Average product measures (Table 6b)		
	Survey (50%+ definition)	PhDs	Authors
Size (Table 1a / Table 1c)	+0.05	-0.12	+0.05
Concentration of PhDs (Table 1b / Table 1a)	-0.29	+0.50	+0.04

Figure 1: Articles and Working Papers, 1999-2003

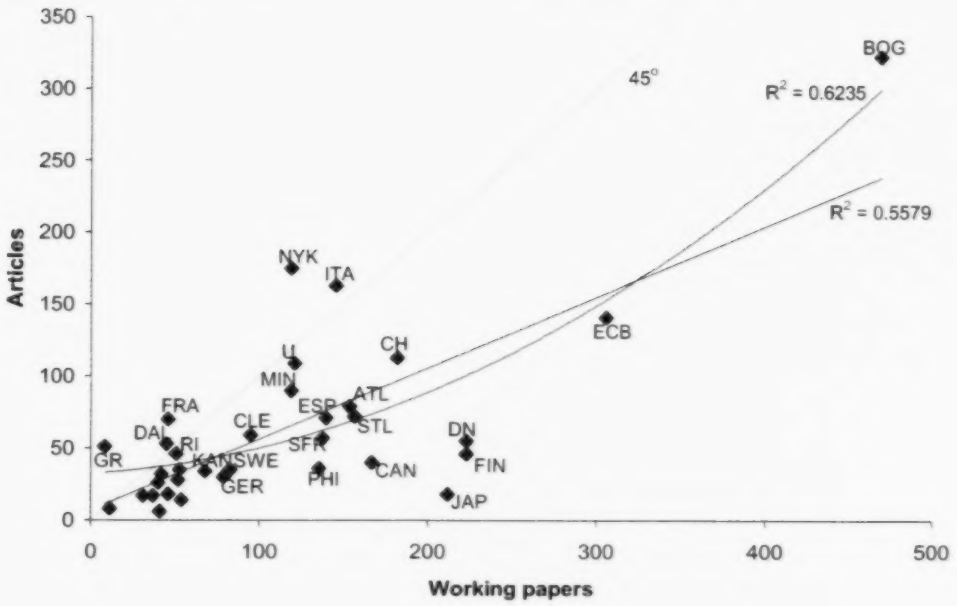


Figure 2: Articles and Working Papers, Excluding External Researchers 1999-2003

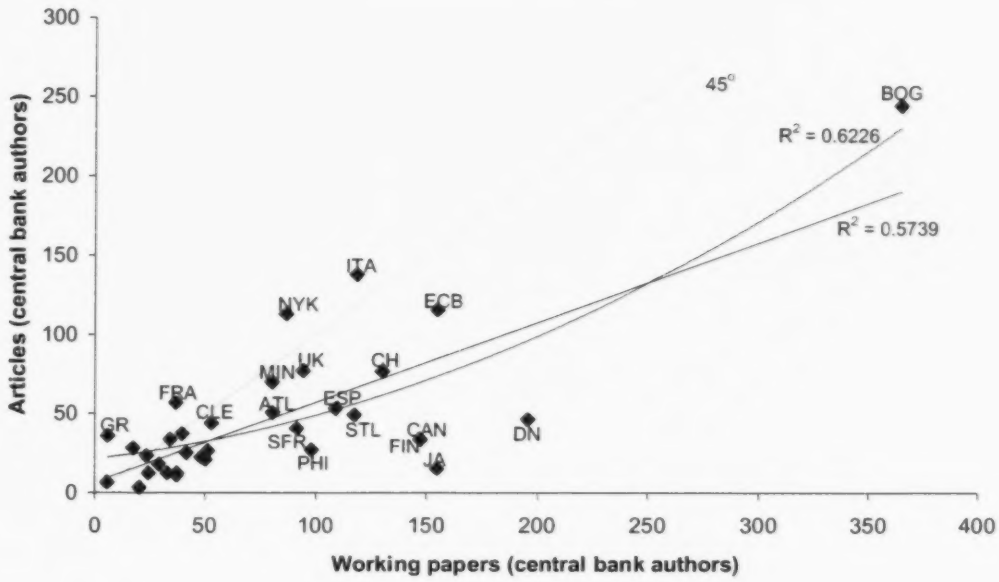


Figure 3: Quality-Adjusted Publications per Researcher and BIS Citations per Researcher, by Ranking, 1999-2003

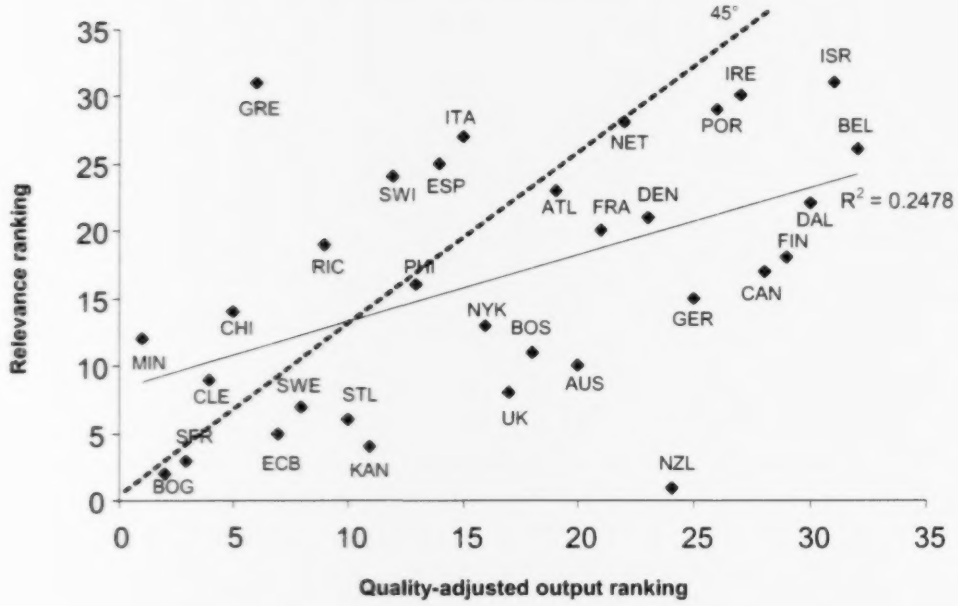


Figure 4a: External Collaboration and Average Product of Researchers, by Ranking, 1999-2003

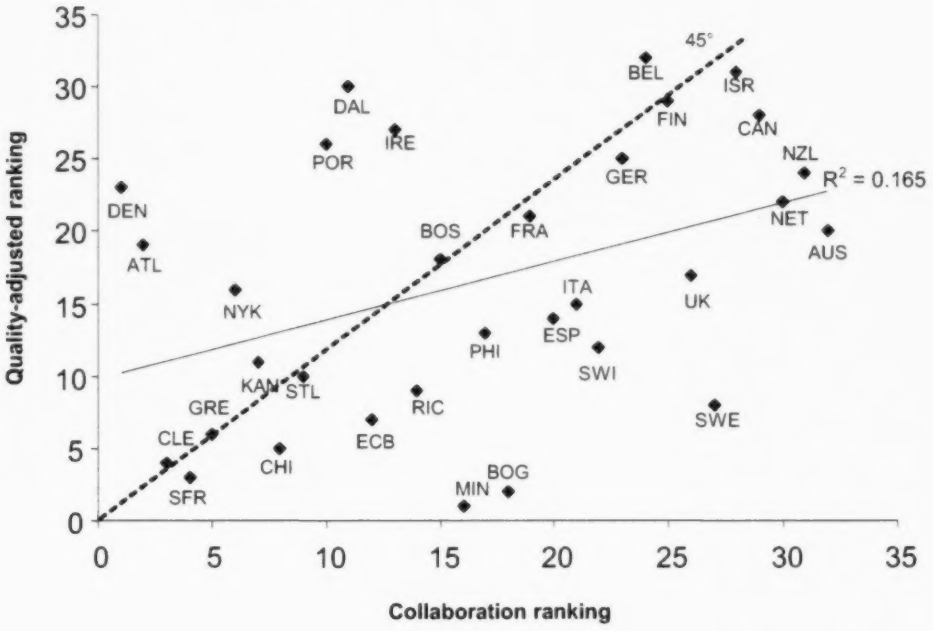


Figure 4b: External Collaboration and BIS Citations per Researcher, by Ranking, 1999-2003

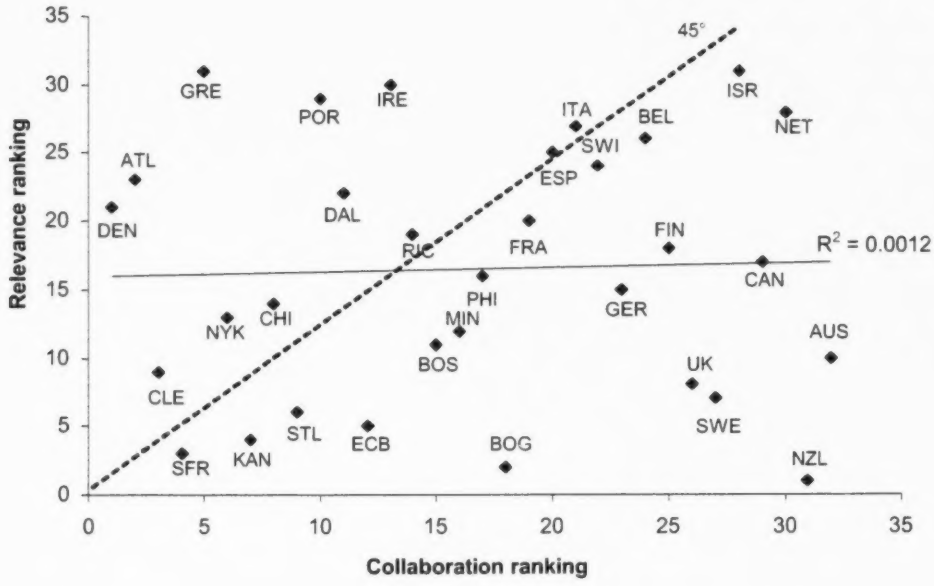


Figure 5a: Researchers and Average Product, by Ranking, 1999-2003

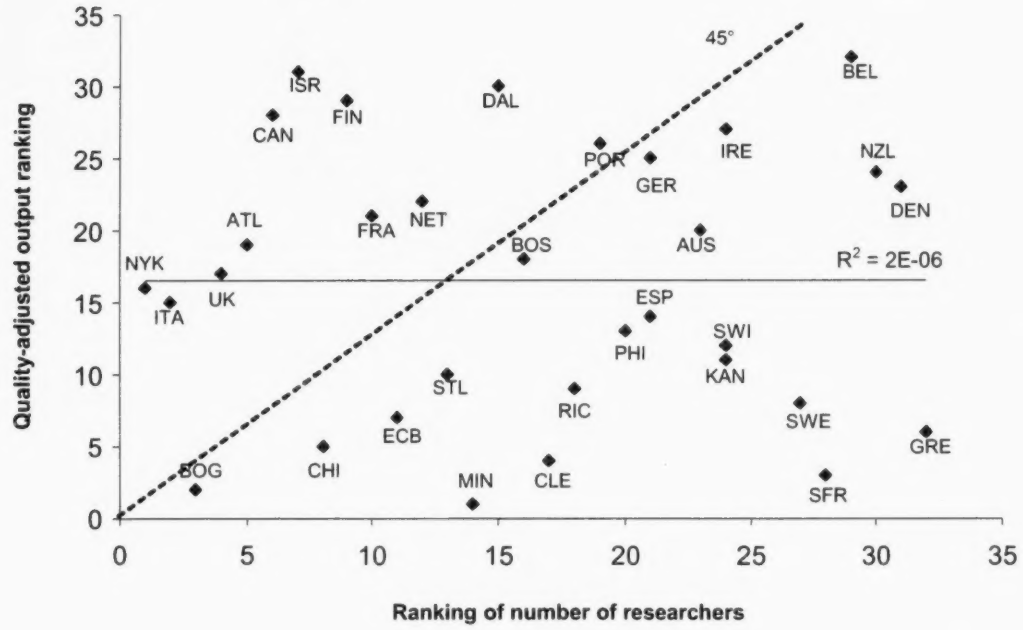


Figure 5b: Researchers and BIS Citations per Researcher, by Ranking, 1999-2003

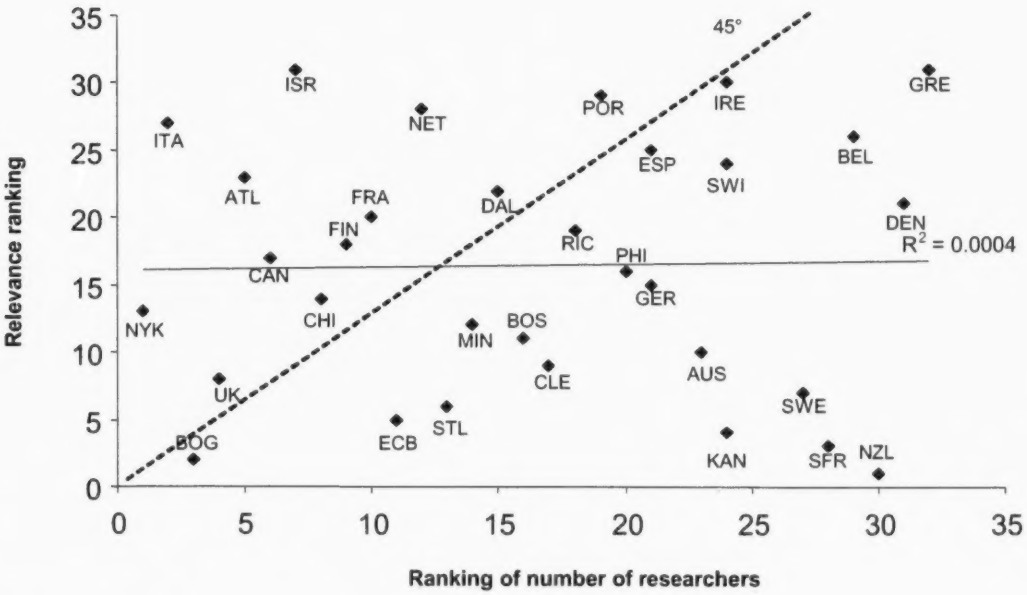


Figure 6a: Ratio of PhDs/Researchers and Average Product, by Ranking, 1999-2003

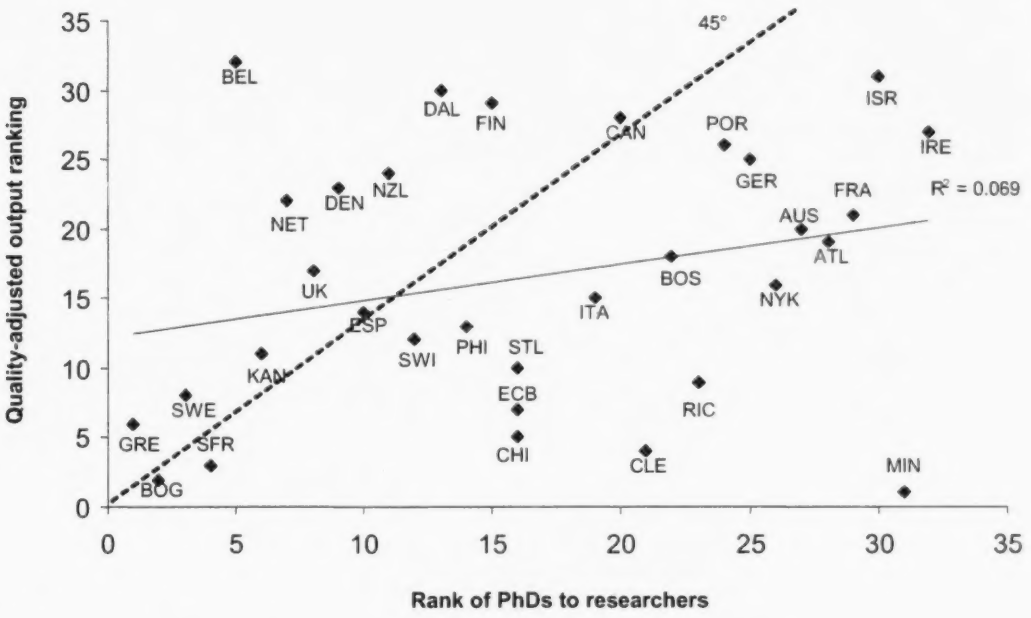
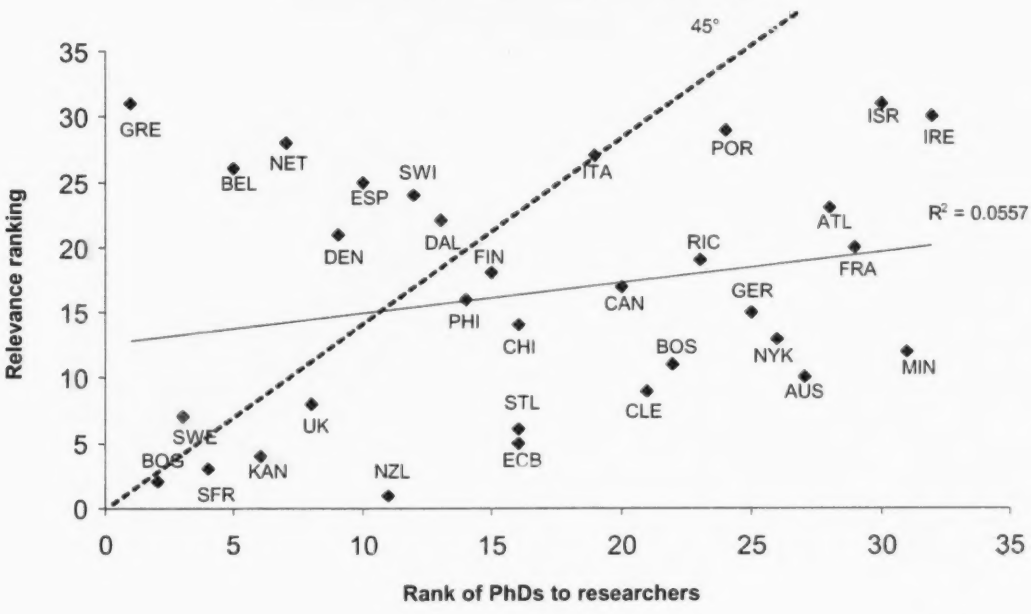


Figure 6b: Ratio of PhDs/Researchers and BIS Citations per Researcher, by Ranking, 1999-2003



Appendix B: Academic Journals and Their Weights

(based on Combes & Linnemer 2003)

Journal Name	Weight
American Economic Review	1.00
Econometrica	1.00
Journal of Economic Theory	1.00
Journal of Political Economy	1.00
Quarterly Journal of Economics	1.00
Review of Economic Studies	1.00
Econometric Theory	0.67
European Economic Review	0.67
Games and Economic Behavior	0.67
International Economic Review	0.67
Journal of Business and Economic Statistics	0.67
Journal of Econometrics	0.67
Journal of Finance	0.67
Journal of International Economics	0.67
Journal of Labor Economics	0.67
Journal of Monetary Economics	0.67
Journal of Money, Credit, and Banking	0.67
Journal of Public Economics	0.67
Journal of the American Statistical Association	0.67
RAND Journal of Economics	0.67
Review of Economics and Statistics	0.67
American Journal of Agricultural Economics	0.50
Canadian Journal of Economics	0.50
Economic Journal	0.50
Economic Theory	0.50
Economics Letters	0.50
Explorations in Economic History	0.50
Industrial and Labor Relations Review	0.50
International Journal of Game Theory	0.50
International Journal of Industrial Organization	0.50
Journal of Applied Econometrics	0.50
Journal of Banking and Finance	0.50
Journal of Business	0.50
Journal of Comparative Economics	0.50
Journal of Development Economics	0.50
Journal of Economic Behavior and Organization	0.50
Journal of Economic Dynamics and Control	0.50
Journal of Economic History	0.50
Journal of Economic Literature	0.50
Journal of Economic Perspectives	0.50
Journal of Economics and Management Strategy	0.50
Journal of Environmental Economics and Management	0.50
Journal of Financial and Quantitative Analysis	0.50
Journal of Financial Economics	0.50
Journal of Health Economics	0.50
Journal of Human Resources	0.50
Journal of Industrial Economics	0.50
Journal of Law and Economics	0.50
Journal of Law, Economics, and Organization	0.50
Journal of Macroeconomics	0.50

Journal of Mathematical Economics	0.50
Journal of Population Economics	0.50
Journal of Risk and Uncertainty	0.50
Journal of Urban Economics	0.50
Land Economics	0.50
Public Choice	0.50
Regional Science and Urban Economics	0.50
Scandinavian Journal of Economics	0.50
Social Choice and Welfare	0.50
Theory and Decision	0.50
Accounting Review	0.33
American Political Science Review	0.33
Annales d'Economie et de Statistique	0.33
Applied Economics	0.33
British Journal of Industrial Relations	0.33
Brookings Papers on Economic Activity	0.33
Cambridge Journal of Economics	0.33
Carnegie-Rochester Conference Series on Public Policy	0.33
Demography	0.33
Economic Geography	0.33
Economic History Review	0.33
Economic Inquiry	0.33
Economic Modelling	0.33
Economic Policy	0.33
Economic Record	0.33
Economica	0.33
Economics and Philosophy	0.33
Economics and Politics	0.33
Economics of Transition	0.33
Energy Economics	0.33
Environment and Planning A	0.33
European Journal of Political Economy	0.33
European Review of Agricultural Economics	0.33
Experimental Economics	0.33
Geneva Papers on Risk and Insurance Theory	0.33
History of Political Economy	0.33
Industrial Relations	0.33
International Journal of Urban and Regional Research	0.33
International Organization	0.33
Journal of Agricultural Economics	0.33
Journal of Common Market Studies	0.33
Journal of Development Studies	0.33
Journal of Economic Growth	0.33
Journal of Economic Studies	0.33
Journal of Empirical Finance	0.33
Journal of Institutional and Theoretical Economics	0.33
Journal of International Business Studies	0.33
Journal of International Money and Finance	0.33
Journal of Post Keynesian Economics	0.33
Journal of Regional Science	0.33
Journal of Regulatory Economics	0.33
Journal of Risk and Insurance	0.33
Journal of the Japanese and International Economies	0.33
Journal of the Royal Statistical Society: Series A (Statistics in Society)	0.33

Kyklos	0.33
Labour Economics	0.33
Marketing Science	0.33
Mathematical Methods of Operations Research	0.33
Mathematical Social Sciences	0.33
Michigan Law Review	0.33
National Tax Journal	0.33
Open Economies Review	0.33
Oxford Bulletin of Economics and Statistics	0.33
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Research Policy	0.33
Review of Financial Studies	0.33
Review of International Economics	0.33
Review of Radical Political Economics	0.33
Weltwirtschaftliches Archiv/Review of World Economics	0.33
Sloan Management Review	0.33
Southern Economic Journal	0.33
Urban Studies	0.33
World Bank Economic Review	0.33
World Development	0.33
World Economy	0.33
Yale Law Journal	0.33
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American Journal of Economics and Sociology	0.17
Antitrust Bulletin	0.17
Applied Economics Letters	0.17
Atlantic Economic Journal	0.17
Australian Economic Review	0.17
Australian Journal of Agricultural and Resource Economics	0.17
Bulletin of Economic Research	0.17
Bulletin of Indonesian Economic Studies	0.17
Business and Economic History	0.17
Canadian Journal of Agricultural Economics	0.17
China Economic Review	0.17
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Contemporary Economic Policy	0.17
De Economist	0.17
Defence and Peace Economics	0.17
Developing Economies	0.17
Development	0.17
Development and Change	0.17
Eastern European Economics	0.17
Ecological Economics	0.17
Econometric Reviews	0.17
Econometrics Journal	0.17
Economic Analysis	0.17
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Economics of Planning	0.17
Energy Journal	0.17

Environment and Planning C: Government and Policy	0.17
European Journal of Development Research	0.17
European Journal of Law and Economics	0.17
European Journal of the History of Economic Thought	0.17
European Review of Economic History	0.17
Federal Reserve Bank of New York Economic Policy Review	0.17
Federal Reserve Bank of San Francisco Economic Review	0.17
Federal Reserve Bank of St. Louis Review	0.17
Finance and Stochastics	0.17
Fiscal Studies	0.17
Food Policy	0.17
Foreign Affairs	0.17
German Economic Review	0.17
Greek Economic Review	0.17
Growth and Change	0.17
Health Economics	0.17
Hitotsubashi Journal of Economics	0.17
Indian Economic Journal	0.17
Insurance: Mathematics and Economics	0.17
Journal of International Money and Finance	0.17
International Economy	0.17
International Finance	0.17
International Game Theory Review	0.17
International Journal of Finance and Economics	0.17
International Journal of Forecasting	0.17
International Labour Review	0.17
International Regional Science Review	0.17
International Review of Economics and Finance	0.17
International Review of Law and Economics	0.17
Jahrbuch fur Regionalwissenschaft/Review of Regional Research	0.17
Japan and the World Economy	0.17
Journal of Accounting and Economics	0.17
Journal of Accounting Research	0.17
Journal of African Economies	0.17
Journal of Agricultural and Resource Economics	0.17
Journal of Applied Statistics	0.17
Journal of Conflict Resolution	0.17
Journal of Consumer Research	0.17
Journal of Developing Areas	0.17
Journal of Economic Development	0.17
Journal of Economic Education	0.17
Journal of Economic Integration	0.17
Journal of Economic Issues	0.17
Journal of Economic Methodology	0.17
Journal of Economic Psychology	0.17
Journal of Economic Surveys	0.17
Journal of Environmental Planning and Management	0.17
Journal of European Economic History	0.17
Journal of Evolutionary Economics	0.17
Journal of Futures Markets	0.17
Journal of Housing Economics	0.17
Journal of Income Distribution	0.17
Journal of International Development	0.17
Journal of International Trade and Economic Development	0.17

Journal of Labor Research	0.17
Journal of Legal Economics	0.17
Journal of Legal Studies	0.17
Journal of Peace Research	0.17
Journal of Policy Modeling	0.17
Journal of Portfolio Management	0.17
Journal of Productivity Analysis	0.17
Journal of Quantitative Economics	0.17
Journal of Real Estate Finance and Economics	0.17
Journal of the History of Economic Thought	0.17
Journal of Transport Economics and Policy	0.17
Journal of World Trade	0.17
Labor History	0.17
Macroeconomic Dynamics	0.17
Managerial and Decision Economics	0.17
Manchester School	0.17
Manchester School of Economics and Social Studies	0.17
Mathematical Finance	0.17
Monthly Labor Review	0.17
National Institute Economic Review	0.17
National Westminster Bank Quarterly Review	0.17
Natural Resources Journal	0.17
New Political Economy	0.17
OECD Economic Studies	0.17
Oxford Development Studies	0.17
Oxford Review of Economic Policy	0.17
Policy Sciences	0.17
Politica Economica	0.17
Population and Development Review	0.17
Population Research and Policy Review	0.17
Population Studies	0.17
Post-Communist Economies	0.17
Post-Soviet Affairs	0.17
Post-Soviet Geography and Economics	0.17
Problems of Economic Transition	0.17
Recherches Economiques de Louvain/Louvain Economic Review	0.17
Resources and Energy	0.17
Resources Policy	0.17
Review of Black Political Economy	0.17
Review of Economic Design	0.17
Review of Income and Wealth	0.17
Review of Industrial Organization	0.17
Review of International Studies	0.17
Review of Social Economy	0.17
Revue d'Economie Politique	0.17
Revue Economique	0.17
Scandinavian Economic History Review	0.17
Scottish Journal of Political Economy	0.17
Small Business Economics	0.17
Statistical Journal	0.17
Statistical Papers	0.17
Structural Change and Economic Dynamics	0.17
World Bank Research Observer	0.17
All other publications	0.08

Appendix C: *EconLit* Search Keywords

Country	Central Bank	Search Criteria
Australia	Reserve Bank of Australia	af reserve bank of australia
Austria	Oesterreichische Nationalbank	af oesterreichische nationalbank or af central bank of austria or af Austrian National Bank
Belgium	Banque Nationale de Belgique	af national bank of belgium or af "banque nationale de belgique"
Canada	Bank of Canada	af (bank of canada not royal not laurentian) or af banque du canada
Denmark	Danmarks Nationalbank	af denmarks nationalbank or af denmark national bank or af danmarks nationalbank or af danmarks national bank
European Union	European Central Bank	af european central bank of af ecb
Finland	Suomen Pankki	af suomen pankki or af finlands bank or af bank of finland
France	Banque de France	af "banque de france" or af bank of france
Germany	Deutsche Bundesbank	af deutsche bundesbank
Greece	Bank of Greece	af bank of Greece not af "national bank of greece"
Ireland	Central Bank of Ireland	af central bank of ireland
Israel	Bank of Israel	af bank of israel no so bank of israel
Italia	Banca d'Italia	af "bank of italy" or af "banca ditalia" or (af "banca" and af "italia")
Japan	Bank of Japan	af bank of japan not so "monetary and economic studies" not af "development bank of japan"
Netherlands	De Nederlandsche Bank	af nederlandsche bank
New Zealand	Reserve Bank of New Zealand	af reserve bank of new zealand
Portugal	Banco de Portugal	af bank of portugal or af "banco de portugal"
Spain	Banco de España	af (bank of spain or "banco de espana") not so "banco de espana economic bulletin"
Sweden	Sveriges Riksbank	af sveriges riksbank or af bank of sweden
Switzerland	Schweizerische Nationalbank	af (swiss national bnak or schweizerische nationalbank or banque nationale suisse) not so schweizerische nationalbnak quartalsheft
United Kingdom	Bank of England	af bank of England
United States	Board of Governors of the Federal Reserve System	af federal reserve board not so federal reserve bulletin / af "federal reserve system" not so federal reserve bulletin
United States	Federal Reserve Bank of Atlanta	af reserve bank of atlanta not so reserve bank of atlanta economic review
United States	Federal Reserve Bank of Boston	af reserve bank of boston ot so federal reserve bank of boston new england economic review not so new england economic review
United States	Federal Reserve Bank of Chicago	af reserve bank of chicago not so reserve bank of chicago economic perspectives
United States	Federal Reserve Bank of Cleveland	af reserve bank of cleveland not so federal reserve bank of cleveland economic review
United States	Federal Reserve Bank of Dallas	af reserve bank of dallas no so "reserve bank of dallas economic and financial review" not so reserve bank of dallas economic review no so financial industry studies
United States	Federal Reserve Bank of Kansas City	af reserve bank of kansas city not so reserve bank of kansas city economic review
United States	Federal Reserve Bank of Minneapolis	af reserve bank of minneapolis not so reserve bank of minneapolis quarterly review
United States	Federal Reserve Bank of New York	af reserve bank of new york not so federal reserve bank of new york economic policy review not so federal reserve bank of new york quarterly review
United States	Federal Reserve Bank of Philadelphia	af reserve bank of philadelphia not so reserve bank of philadelphia business review
United States	Federal Reserve Bank of Richmond	af reserve bank of bank of richmond not so reserve bank of richmond economic quarterly not so reserve bank of richmond economic review
United States	Federal Reserve Bank of San Francisco	af reserve bank of san francisco no so reserve bank of san francisco economic review
United States	Federal Reserve Bank of St. Louis	af federal reserve bank of st louis not so federal reserve bank of st. louis review

Appendix D: BIS and U.S. Fed Search Keywords

Country	Central Bank	Search Criteria
Australia	Reserve Bank of Australia	"reserve bank of australia", "discussion paper", "reserve bank bulletin"
Austria	Oesterreichische Nationalbank	"oesterreichische nationalbank", "austrian national bank", "austrian nationalbank","bank of austria", "focus on austria", "focus on transition", "financial stability report"
Belgium	Banque Nationale de Belgique	"national bank of belgium", "nbb working paper", "banque nationale de belgique", "revue économique"
Canada	Bank of Canada	"bank of canada working paper", "working paper bank of canada", "banque du canada document de travail", "document de travail banque du canada", "bank of canada technical report", "technical report no", "rapport technique banque du canada", "technical report bank of canada", "rapport technique no", "bank of canada review", "revue de la banque du canada"
Denmark	Danmarks Nationalbank	"danmarks nationalbank", "danmarks national bank", "denmark national bank" "national bank of denmark", "monetaty review"
European Union	European Central Bank	"ecb working paper", "european central bank working paper", "ecb occasional paper", "european central bank occasional paper", "monthly bulletin"
Finland	Suomen Pankki	"suomen pankki", "finlands bank", "bank of finland", "discussion paper"
France	Banque de France	"banque de france", "bank of france", "notes d'études et de recherche", "notes d'etude", "france working paper", "ner", "bulletin digest", "bulletin trimestriel", "france quarterly bulletin", "bulletin de la france", "financial stability review", "revue de la stabilité financière"
Germany	Deutsche Bundesbank	"discussion paper", "bundesbank discussion", "bundesbank working", "monthly report", "deutsche bundesbank"
Greece	Bank of Greece	"bank of greece", "economic bulletin"
Ireland	Central Bank of Ireland	"central bank of ireland", "ireland bulletin", "research technical paper"
Israel	Bank of Israel	"bank of israel", "israel economic review", "israel banking review"
Italia	Banca d'Italia	"temi di discussione", "banca d'italia", "bank of italy"
Japan	Bank of Japan	"monetary and economic studies", "quarterly bulletin bank of japan", "bank of japan quarterly bulletin", "bank of japan working paper", "imes discussion paper"
Netherlands	De Nederlandsche Bank	"nederlandsche bank staff", "nederlandsche bank qarterly"
New Zealand	Reserve Bank of New Zealand	"discussion paper", "research paper", "reserve bank bulletin","reserve bank of new zealand", "rbnz"
Portugal	Banco de Portugal	"banco de portugal", "bank of portugal"
Spain	Banco de España	"banco de espana", "bank of spain", "banco de españa", "spain working paper", "documento de trabajo", "spanish central bank", "economic bulletin", "boletin econmico", "estudios econmicos"
Sweden	Sveriges Riksbank	"sveriges riksbank working paper", "bank of sweden", "sveriges riksbank economic review", "sveriges riksbank quarterly review", "arbetsrapport"
Switzerland	Schweizerische Nationalbank	"swiss national bank", "scheweizerische nationalbank", "banque nationale suisse", "quartalsheft"
United Kingdom	Bank of England	"bank of england working paper", "working paper bank of england", "bank of england discussion", "financial stability review", "bank of england quarterly bulletin"
United States	Board of Governors of the Federal Reserve System	"federal reserve bulletin", "bulletin federal reserve", "reserve board bulletin", "staff studies", board staff studies", "staff study","finance and economics discussion", "international finance discussion", "ifs discussion paper"
United States	Federal Reserve Bank of Atlanta	"bank of atlanta"

United States	Federal Reserve Bank of Boston	"bank of boston", "fed boston","new england economic review"
United States	Federal Reserve Bank of Chicago	"bank of chicago"
United States	Federal Reserve Bank of Cleveland	"bank of cleveland"
United States	Federal Reserve Bank of Dallas	"bank of dallas"
United States	Federal Reserve Bank of Kansas City	"bank of kansas"
United States	Federal Reserve Bank of Minneapolis	"bank of minneapolis"
United States	Federal Reserve Bank of New York	"bank of new york staff reports", "FRBNY staff", "york working paper", "staff report federal reserve", "economic policy review", "york quarterly"
United States	Federal Reserve Bank of Philadelphia	"bank of philadelphia", "business review"
United States	Federal Reserve Bank of Richmond	"bank of richmond", "richmond", "economic quarterly"
United States	Federal Reserve Bank of San Francisco	"bank of san francisco"
United States	Federal Reserve Bank of St. Louis	"bank of st. louis"

Appendix E: Working Papers

Central Bank	Working Paper Series
Banca d'Italia	Termi di Discussione, Historical Research Papers
Banco de Espana	Working Papers, Economic Studies, Economic History Studies
Banco de Portugal	Working Papers
Bank of Canada	Working Papers, Technical Reports
Bank of England	Working Papers
Bank of Finland	Working Papers, Studies in Economics and Finance, BOFIT Discussion Papers
Bank of Greece	Working Papers
Bank of Israel	Research Department Discussion Papers, Monetary Department Discussion Papers
Bank of Japan	IMES Discussion Papers, Working Papers
Banque de France	Working Papers
Board of Governors of the Federal Reserve Board	Finance and Economic Discussion Series, International Finance Discussion Papers
Central Bank of Ireland	Research Technical Papers
Danmarks Nationalbank	Working Papers
De Nederlandsche Bank	WO Research Memoranda, MEB Series, Research Series Supervision, DNB Staff Reports, DNB Occasional Studies
Deutsche Bundesbank	Diskussionspapiere
European Central Bank	Working Paper Series, Occasional Paper Series
Federal Reserve Bank of Atlanta	Working Papers, Research Reports
Federal Reserve Bank of Boston	Working Papers
Federal Reserve Bank of Chicago	Working Papers, Consumer and Community Affairs Policy Studies, Emerging Issues Series, Occasional Papers; Emerging Payments
Federal Reserve Bank of Cleveland	Working Papers, Policy Discussion Papers
Federal Reserve Bank of Dallas	Working Papers, Centre for Latin American Economics (CLAE) Working Papers
Federal Reserve Bank of Kansas City	Research Working Papers, Payments System Research Working Papers
Federal Reserve Bank of Minneapolis	Working Papers, Discussion Papers, Staff Reports
Federal Reserve Bank of New York	Staff Reports
Federal Reserve Bank of Philadelphia	Working Papers, Payment Cards Center Discussion Papers
Federal Reserve Bank of Richmond	Working Papers
Federal Reserve Bank of San Francisco	Working Papers, Pacific Basin Working Papers
Federal Reserve Bank of St. Louis	Working Papers
National Bank of Belgium	Working Papers
Oesterreichische Nationalbank	Working Papers
Reserve Bank of Australia	Research Discussion Papers
Reserve Bank of New Zealand	Discussion Papers, Research Papers
Schweizerische Nationalbank	Working Papers
Sveriges Riksbank	Working Papers

Bank of Canada Working Papers
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Working papers are generally published in the language of the author, with an abstract in both official languages. ***Les documents de travail sont publiés généralement dans la langue utilisée par les auteurs; ils sont cependant précédés d'un résumé bilingue.***

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